Vol. XL December, 1956 No. 7

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
University of the Philippines

CONTENTS

Responses of Coffee to Deficiency of Various Elements in the Culture Medium ..... *E. A. Ochavillo* 315

The Nature of Lodging in Rice ..... *D. A. Ramirez and D. L. Umali* 335

The Effect of Two Herbicides on Rice Plants Sprayed at Different Stages of Growth ..... *R. K. de la Fuente S. N. Fertig, and P. A. Llena* 352

Control of Tobacco Insects with Organic Insecticides ..... *G. B. Viado, E. C. Punzalan, and A. F. Banaag* 361

Growth in Weight of Berkjala and Berkshire Suckling Pigs ..... *V. Villegas* 378

Major Philippine Agricultural Exports in 1954 ..... *E. M. Varona* 380

The Effect of Aurofac Upon the Rate of Growth of Growing-Fattening Pigs ..... *F. S. Mensalvas and Q. M. Sugon* 385

Suitability and Fertilizing Values of Horse Beddings ..... *V. Villegas, J. C. Madamba, and L. L. Austria* 386

The Comparative Values of the Carcass of Rams and Wethers ..... *V. Villegas* 387

A Comparison of the "Filter Paper" and A.O.A.C. Methods of Moisture Determination in Molasses ... *R. Ponciano N. Obed* 388

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A
Published at College, Laguna

COMMONWEALTH MYCOLOGICAL INSTITUTE
APR 1957

The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
University of the Philippines

EDITORIAL STAFF

J. R. VELASCO, Editor
G. D. FELICIANO, Acting Associate Editor
J. M. CAPINPIN, Business Manager
G. B. VIADO, Animal Sciences
J. BANZON, Physical Sciences
D. L. UMALI, Plant Sciences
G. F. SAGUIGUIT, Social Sciences

ADMINISTRATIVE STAFF

L. B. UICHANCO ..... Dean and Director
F. O. SANTOS ..... Assistant Dean and Assistant Director
J. M. CAPINPIN ..... Head, Department of Agricultural Botany
L. J. VILLANUEVA ..... Acting Head, Department of Agricultural Chemistry
P. R. SANDOVAL ..... In-Charge, Department of Agricultural Economics
G. F. SAGUIGUIT ..... Head, Department of Agricultural Education
A. B. CATAMBAY ..... Head, Department of Agricultural Engineering
V. C. CALMA ..... Head, Department of Agronomy
L. S. CASTILLO ..... Acting Head, Department of Animal Husbandry
S. M. CENDAÑA ..... Head, Department of Entomology
L. U. OÑATE ..... In Charge, Department of Home Technology
N. G. DUNGLAO ..... Head, Department of Languages
F. T. ORILLO ..... Head, Department of Plant Pathology
N. L. GALVEZ ..... Head, Department of Soils

THE PHILIPPINE AGRICULTURIST is published monthly except in April and May by the College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and $0.50 elsewhere.

Authors of articles appearing in THE PHILIPPINE AGRICULTURIST are severally responsible for the opinions expressed therein.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed to the Library of the College of Agriculture and Central Experiment Station, University of the Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter.

RESPONSES OF COFFEE TO DEFICIENCY OF VARIOUS ELEMENTS IN THE CULTURE MEDIUM[1]

E. A. OCHAVILLO [2]

WITH TWENTY-FIVE TEXT FIGURES

Coffee plants grown in sand and watered with various modifications of Hoagland's solution B initiated deficiency symptoms at different times. In no-nitrate culture, the plants appeared chlorotic in two or three weeks while without phosphorus the plants did not show distinct symptoms even at 10 months after treatment. Early symptoms of certain nutrient deficiencies were markedly identical. The older leaves in the no-calcium cultures had necrotic margins like those of the no-potassium and the younger leaves were chlorotic similar to those of the no-sulfur cultures. However, when the deficiency became acute the no-clacium plants produced young leaves with golden brown margin and the shoot apex dried up.

Number of leaves, leaf area, and height decreased whenever a nutrient deficiency was established.

This experiment was conducted to produce symptoms that might be of use as diagnostic criteria in determining needs of coffee plants growing in the field.

MATERIALS AND METHODS

Coffee seeds of the Bukidnon strain sown on December 30, 1954 in the Manambulan Experiment Station, Davao were brought to College on April 20, 1955. These were planted in sand and watered with Hoagland's complete culture solution No. 2 to get them established. On July 25 the healthy plants were transplanted in about 30 kilos of acid-washed white sand contained in a pot 38 cm. in diameter and 34 cm. deep.

After treatment with 2% HCl and thorough washing with tap water, the sand contained 99.4% silica and traces of iron and potassium.

On August 9 the plants were selected at random and given solutions which were alternately deficient in one of the essential elements.

---

[1] Central Experiment Station Contribution No. 1916. Coffee and Cacao Development Project.

[2] The author gratefully acknowledges the help of Dr. J. R. Velasco, Research Associate Professor of Plant Physiology, in planning and conducting this experiment. Thanks are also due Mr. D. Pascual for supplying the coffee seedlings.

At the early stage of the experiment the plants were given one liter of the solution. This was increased to one and one-half liters when the plants were 90 days old. Between the weekly schedule of irrigating with culture solution, the plants were given one liter of distilled water or demineralized water to replace the water lost by evaporation.

Cheesecloth was spread above the plants to provide diffused light. Biweekly measurements of height, number of leaves and leaf area were taken. Leaf area was determined by matching with leaf patterns of known areas. A visual symptom of deficiency was considered typical when at least three of the four plants treated showed it consistently.

EXPERIMENTAL RESULTS

No-nitrate culture. In two or three weeks after treatment the plants became conspicuously light green. Shortly thereafter, the young leaves turned light yellow. Older leaves were light green while the oldest leaves turned bright yellow and eventually dried back from the tips. For about two weeks during the sixth month of the experiment demineralized water was used instead of distilled water in making up solutions. It was noted that younger leaves gradually turned green and plants initiated rapid growth of leaf buds. When distilled water was used in the culture solution, the younger leaves resumed their former yellow color in about three weeks. The leaves were stiff, small, narrow with margins turned upward and borne about 90 degrees with the stem. The plants were short and sparingly branched. Figures 1 and 2 show marked differences between the no-nitrate plants and the control.

No-ammonium culture. A month after treatment, the plants produced light green leaves with tips cupped upward (fig. 3). Some leaves were deformed so that one side of the blade became narrow from the fifth to the eighth vein and the tip deflected to this side (fig. 4). Six months after treatment the older leaves of the main axis and lateral branches were chlorotic along the midrib and veins, the chlorosis gradually spreading throughout the lamina, leaving green tints on some portions. Leaves defoliated prematurely especially during the hot days of April and May. During the other months the older leaves did not fall off so badly and the plants tended to assume normal appearance (fig. 5).

Fig. 1.—There is marked difference in height, carriage of leaves, number and position of laterals between the no-nitrate and complete cultures.

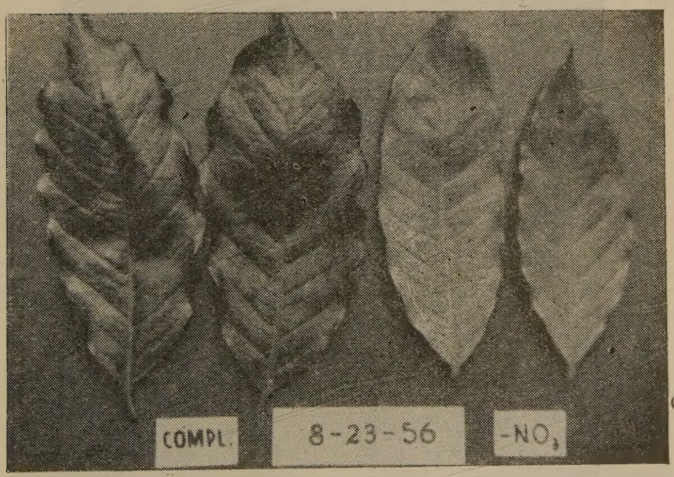

Fig. 2.—Leaves of no-nitrate cultures are much reduced and chlorotic compared with leaves of complete cultures.

Fig. 3.—Leaves of the no-ammonium culture are curling towards the stem. Note the difference in height and mode of branching between no-ammonium and complete cultures.

Fig. 4.—A no-ammonium malformed leaf showing the narrow blade from the fifth to the eighth vein and the tip deflecting to the affected side.

Fig. 5.—There is marked difference in height but mode of branching are alike between the no-ammonium and complete cultures.

No-phosphate culture. During the first eight months of treatment the plants were tall, vigorous, and sturdy. Older leaves were dark green, broad and thick. On the ninth month the four plants gradually exhibited light yellow younger leaves (fig. 6) and a few

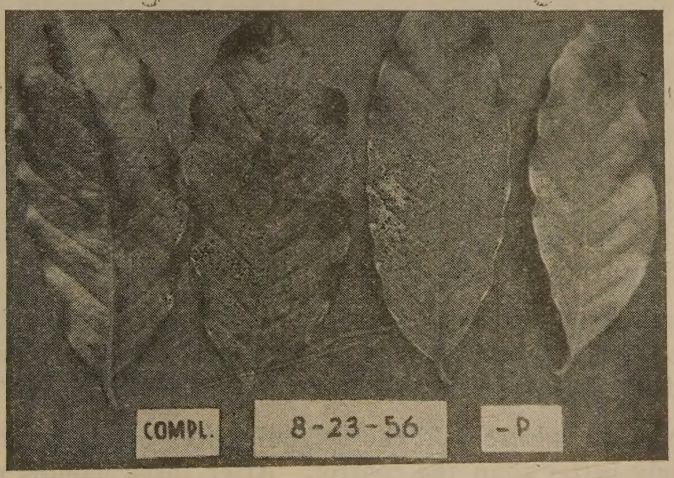

Fig. 6.--Leaves of no-phosphorus culture are chlorotic throughout the lamina and are smaller in size than leaves of the complete culture.

older leaves produced reddish and brown spots along the margins. Thereafter the foliage appeared light yellow and growth was retarded (fig. 7).

Fig. 7.—No-phosphorus culture has fewer and smaller leaves compared with the complete culture.

No-potassium culture. Three weeks after treatment the tips of the old leaves dried first and yellowish spots appeared along the margins. The spots enlarged, gradually connecting with each other and eventually the leaf was fringed with a brown margin (fig. 8). Finally, the entire leaf dried and fell off. The shedding of mature leaves continued for four months. In the next four months the deficiency seemed more severe for there was a general scorching of the old leaves extending to even the second youngest pair of leaves. At this time, shedding of the injured leaves was rapid leaving only three to four pairs of leaves in each branch.

Internodes were long and slender and only a few branches were produced. At the start they were tall but when deficiency worsened they became shorter than the complete culture (fig. 9).

No-calcium culture. At the beginning, the plants were tall and vegetatively better than the control. After three months of treatment the three youngest pairs of leaves turned pale, resembling the young leaves of plants deficient in sulfur. Older leaves which were

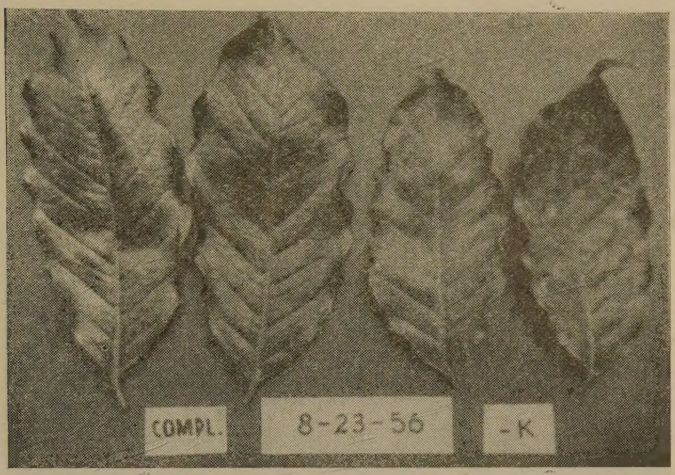

Fig. 8.—Leaves of no-potassium culture have necrotic margins and the injury is progressing towards the midrib.

Fig. 9.—No-potassium culture is short, internodes are farther apart, and there are few leaves compared with the complete culture.

dark-green had dried tips and margins. Some of the leaf budtips were drying. On the sixth month, the first three of four youngest pairs of leaves had golden brown margins covering half the blade, and the other half adjacent to the midrib were green (fig. 10). The next two pairs of leaves had yellow margins. The shoot apex died and many of the apical leaf buds dried up. Heavy defoliation of the older leaves occurred at the seventh and eighth months (fig. 11).

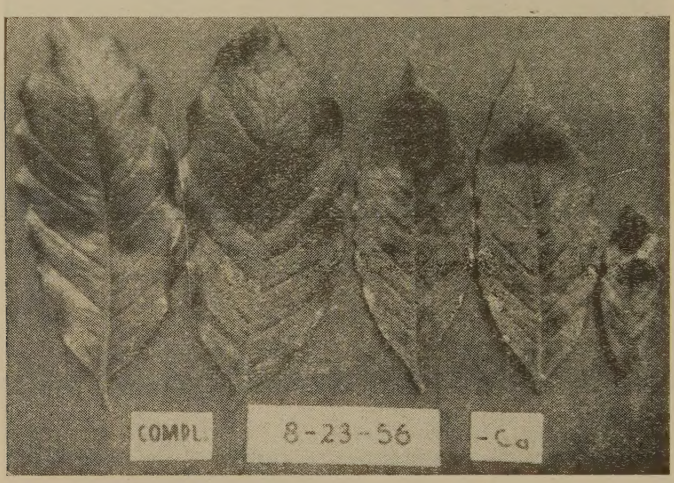

Fig. 10.—There is a difference in the color of the leaf margins of the no-calcium and complete culture. In actual specimens the leaf margins of the no-calcium culture are golden brown.

No-magnesium culture. On the third month of treatment the mature leaves on the main axis had chlorotic interveinal areas. Grayish small circular areas were scattered along the margins, a number of which were concentrated near the tips of the leaves (figs. 12, 13, & 14). Young leaves were dark green and thick. In the succeeding months the older leaves on the lateral branches also showed these symptoms. Drying of the leaves was most severe on the seventh and eighth months when even the third youngest pairs of leaves became affected. There was a gradual but incessant fall of affected leaves leaving only three or four pairs to each branch. Forty-five days after the heavy defoliation the apical buds of the branches became black. Die back had taken place in all plants on the eleventh month. Figure 15 shows a typical die back of branches and death of the no-magnesium plants.

Fig. 11.—No-calcium is shorter than the complete culture. Note the die back of some of the branches.

Fig. 12.—No-magnesium culture is as good as the complete culture but some of the older leaves of the no-magnesium culture shows the deficiency.

Fig. 13.—Leaves of no-magnesium culture have chlorotic interveinal areas with dead spots near the tip.

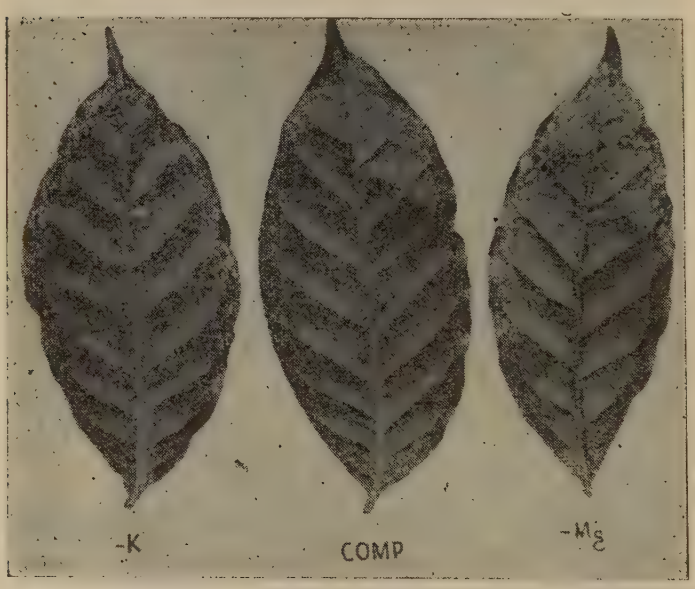

Fig. 14.—A definite pattern of injury in both no-potassium and no-magnesium cultures. Note that in the no-magnesium leaf the interveinal areas are chlorotic and dead spots are concentrated near the tip, while in the no-potassium leaf dead areas are concentrated along the margins and the adjacent areas are green.

Fig. 15.—The no-magnesium culture died when the deficiency was severe while the complete culture has heavy foliage.

No-sulfate culture. About two months after treatment the plants became conspicuously yellow. The two to three pairs of youngest leaves on the main axis and branches had yellow interstitial tissues and light green veins and veinlets (fig. 16). The rest of the

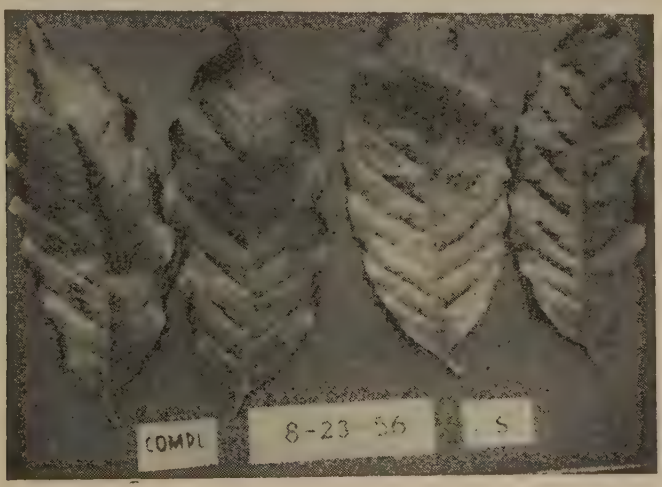

Fig. 16.—The leaves of the no-sulfur culture are chlorotic with light green veins and veinlets but their sizes are comparable with the leaves of the complete culture.

leaves were bright yellow. About six months after the start of the treatment the leaves turned green because the plants were irrigated with demineralized water for two consecutive weeks. Five weeks later they again showed the deficiency when they were supplied with distilled water. In general, they appeared more yellow than the plants deficient in nitrate. The plants were short and produced few branches (fig. 17).

Fig. 17.—The no-sulfur culture is short but the mode of branching is identical with the complete culture.

No-boron culture. Older leaves were broad and dark green. Five months after treatment the second youngest pair of leaves had dead spots scattered throughout the leaf. Young leaves became distorted (fig. 18), and a number of leaf buds on the lateral branches were becoming dry. Soon the leaf buds on the main axis died, giving rise to water sprouts. As shown in fig. 19, the water sprouts produced short internodes. The size of stems were comparable with the stem of the complete culture, but they were weak and had the tendency to break off.

No-zinc culture. The plants were normal until the seventh month after treatment. Then the plants produced chlorotic areas along the midrib and leaf veins on the main axis, turning bright yellow. Heavy defoliation took place during the following months. Many water sprouts grew vigorously at the base of the stem (fig. 20).

Fig. 18.—The leaves of the no-boron culture are distorted and growth is hindered.

Fig. 19.—There is marked difference in height, mode of branching and length of internodes between the no-boron and the complete cultures.

Fig. 20.—Unlike the complete culture no-zinc culture defoliated many of the older leaves and many watersprouts shoot off at the basal portions.

No-iron culture. Plants were normal until about seven and a half months after treatment. Thereafter the plants produced chlorotic leaves with light green midribs and veins. The older leaves turned bright yellow, dried and fell off especially during the dry spell (fig. 21).

No-manganese culture. On the eighth month after treatment, the leaves developed pale yellow areas along the midrib and veins which gradually became bright yellow. The yellow areas ultimately spread over the whole leaf. Shortly after becoming bright yellow the leaves became dry and fell off. Shedding of the leaves was greatest on the tenth month. Plants apparently recovered their normal appearance two months later (fig. 22).

Height of plants, number and area of leaves. The curve of growth in height (fig. 23) of the complete culture assumed an aproximately straight line with a slope of about 0.27 cm. There was a slight deviation from linearity at the start (August and September, 1955) and towards the end of observation (March and April, 1956).

Fig. 21.—The no-iron culture is shorter than the complete culture. Note that most of the older leaves of the no-iron culture had defoliated.

Fig. 22.—The no-manganese culture is as vigorous as the complete culture.

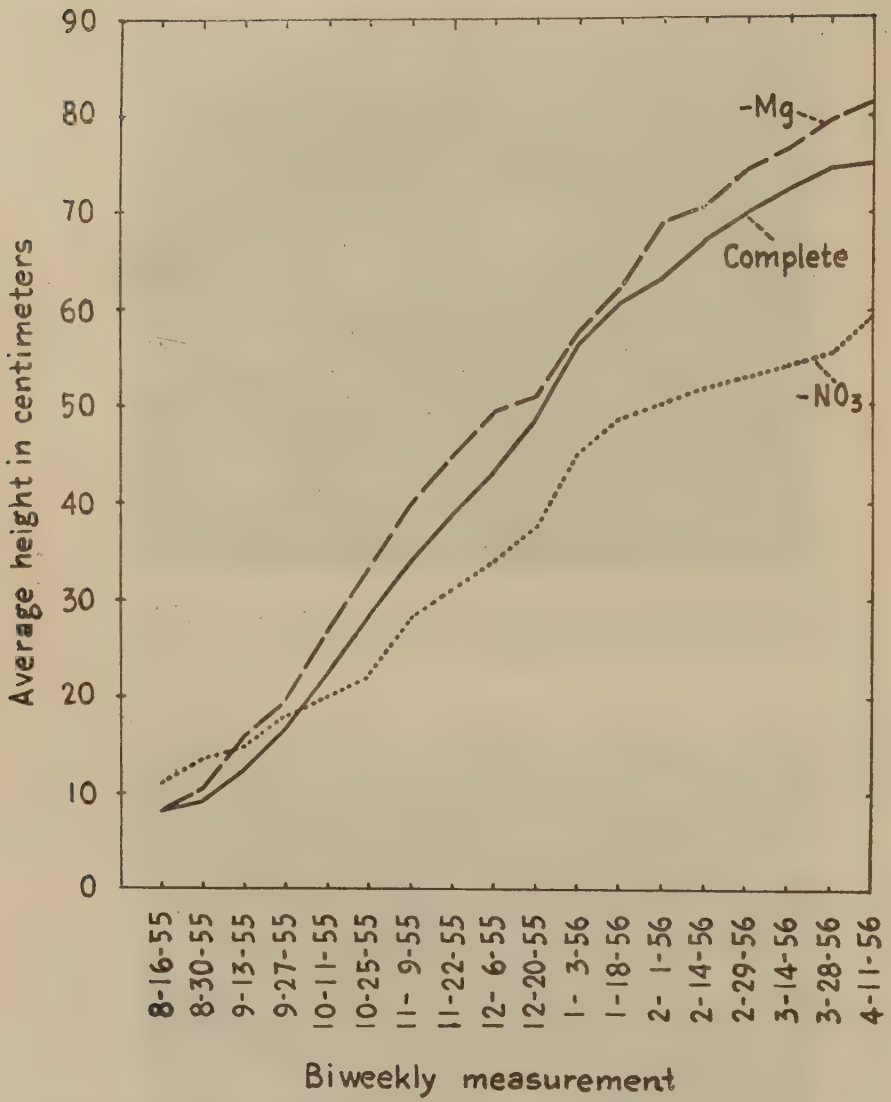

Fig. 23.—Growth in height of cultures receiving the no-magnesium, complete and no-nitrate cultures.

The no-nitrate cultures were taller than the complete cultures during the first seven weeks. On the ninth week they became shorter than the complete culture and were progressively left behind thereafter. At the end of the observation the difference between the two lots was about 15 cm.

The plants without ammonium and sulfur assumed the same trend as the no-nitrate culture.

The no-magnesium culture was taller than the complete culture. In December and January, it hardly grew and so was almost overtaken by the latter. However, in February, it picked up and ended up about 5 cm. taller than the control. The curves of the no-phosphorus and no-potassium cultures were identical with the no-magnesium culture. Velasco and Cabrera [3] found that in abacá the no-magnesium and no-phosphorus cultures maintained a better trend of growth than the control. The boron-and-calcium-free cultures were almost as good as the complete culture.

In the first six weeks, the leaf count was aproximately the same in the different cultures. This shows that at this stage, the deficiencies were not yet so critical as to be considered a major contributory factor to leaf fall. Shortly thereafter, however, a decrease was observed in nearly all the deficient cultures. Except for the no-magnesium and no-calcium cultures which maintained an even greater leaf count than the control, all the cultures consistently gave decreasing leaf counts until the end of the experimental period.

With a few exceptions, there were no marked differences in leaf area among the cultures during the first two months of treatment (fig. 25). A very marked deviation from the curve of the complete culture was however observed in the case of the cultures without nitrate, ammonium and potassium during the last three months of observation. They gave a consistently less leaf area until the end of the sixth month, whereas, the no-calcium and no-magnesium cultures gave a consistently greater leaf area beginning with the first month until the end of the fifth month. Of the two latter cultures, the no-magnesium culture picked up towards the end thus giving an even greater leaf area after the last measurement than the control.

DISCUSSION

Initiating nutrient deficiencies on coffee plants are well manifested in plants without macro-elements except phosphorus. However, some visual symptoms overlapped with each other for sometime. In the case of the no-calcium cultures they produced dried tips and margins of the older leaves similar to the no-potassium cul-

[3] J. R. Velasco and T. E. Cabrera, *Philippine Agriculturist*, 40, 2 (1956).

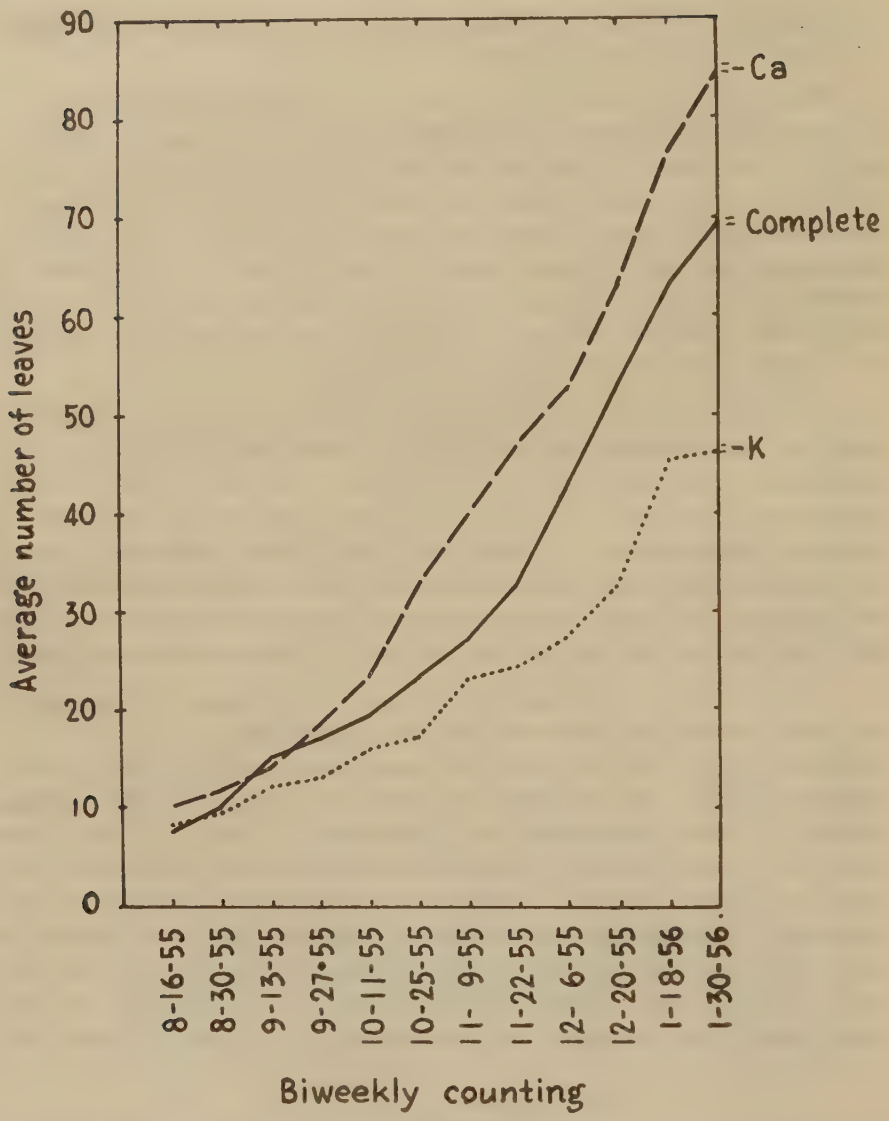

Fig. 24.—Monthly leaf counts on plants receiving no-calcium, complete and no-potassium solutions.

tures. Later, the no-calcium cultures produced golden brown margins and dead apical buds causing death of branches, while the no-potassium cultures continued producing dried margins and tips to the second youngest leaf. No-ammonium cultures produced malformed leaves and chlorotic older leaves at the earlier stage. No-

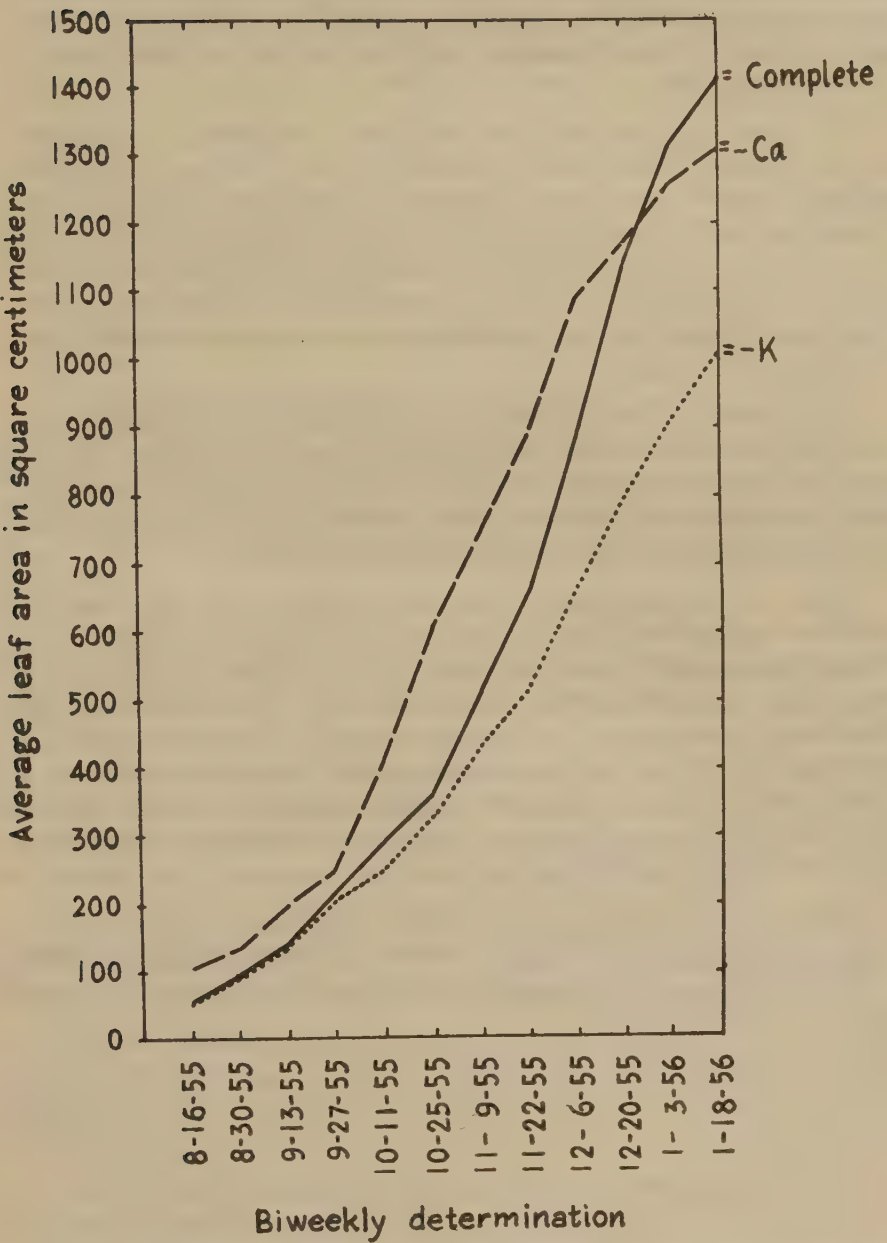

Fig. 25.—Monthly total leaf area on each plant of cultures receiving complete, no-calcium and no-potassium solutions.

manganese-and-zinc cultures produce chlorotic older leaves and when these were defoliated during the dry spell, the remaining one appeared normal. These behavior might be due to the ample supply of other nutrients.

The symptom produced in the absence of magnesium had a definite and characteristic pattern similar to the findings of Mayne.[4] S'Jacob[5] found that plants lacking in potassium had difficulty in showing clearly the symptoms but in this experiment the plants began to manifest the absence of potassium on the third week and thereafter progressively inflicted a severe injury on the leaves. The symptoms of boron and sulfur deficiencies were similar to the findings of van der Veen.[6]

The number of leaves and leaf area decreased when the deficiencies were established since the injured leaves were either prematurely or easily defoliated. During the dry spell, all cultures shed their leaves but the deficient plants especially the potassium, calcium and magnesium cultures were much affected.

Some of the deficiency symptoms produced may be used to ascertain the needs of the coffee plants in the field. However, it is hard to pin-point what the plant actually needs because of the complicated interactions that may influence the appearance and the physiological function of the plants as well. The identical visual symptoms in color of the leaves and stand of the plants deficient in nitrate and sulfate are difficult to distinguish in a coffee plantation. Another is the drying of the tips and margins of the older leaves deficient in potassium and calcium.

---

[4] W. W. Mayne, *Planters' Chronicle*, 36, 327-330 (1940).

[5] J. C. S'Jacob, *Physiological experiments on the nutrition of Coffea arabica* L. (abst.), 2, 2-45 (1938).

[6] R. van der Veen, *Physiological experiments on the nutrition of Coffee* III (abst.), 3, 199-224 (1940).

THE NATURE OF LODGING IN RICE [1]

DOLORES A. RAMIREZ and DIOSCORO L. UMALI

WITH FOUR TEXT FIGURES

Lodging in upland rice was mostly stalk lodging; in lowland, mostly root lodging. High breaking strength of straw and shortness of the first two internodes could be used as an indication of stiffness of upland rice stalk. The thickness of culm wall and of the sclerenchyma cells at the second internode are related to resistance to lodging of both types of rice. Varietal growing habit may also be used in detecting resistance to lodging.

This work was undertaken to study (1) the diagnostic characters which may be used to distinguish root from stalk lodging, (2) the changes in stiffness of stalk at different stages of growth of rice, and (3) the relation of some agronomic and morphological characters of the plant to root and stalk lodging in upland and lowland rice varieties.

The work was conducted from May, 1955 to January, 1956, at the Central Experiment Station of the U.P. College of Agriculture and in the laboratory of the Division of Plant Breeding.

MATERIALS AND METHODS

The upland varieties used were: lodgers—Sinaba, Lady Wright, and Ac 360 Ptb 10; medium lodgers—Azucena, Fortuna, and Guinata; non-lodgers—Milfor 6 (1), Milfor 6 (2), and Palawan.

The lowland varieties included: lodgers—Guinangang, Ac 2270 Kohumawi, and Nagadhan; medium lodgers—Milagrosa, B-E-2, and Masa; non-lodgers—Milfor 6 (2), Dehlingla, and Canoni.

Varietal grouping was based on their standability in the yield trials of the Division of Plant Breeding in 1954. Three hundred hills with one plant to a hill spaced 20 x 40 cm. were grown for each variety.

A spring balance with calibrations of 25 grams was used to determine the breaking strength of the straw.

---

[1] Central Experiment Station Contribution No. 1917.

In determining the pulling strength of the different rice varieties, a wood stand on four legs with a differential pulley and a direct reading scale which registered the resistance of the plants to pulling was used. The pulley arrangement provided a mechanical advantage of 4.

Distinguishing root from stalk lodging. In differentiating stalk from root lodgings the lodged stalks were cut close to the ground and the sheaths were peeled off to expose the stem. If the point of bending was in the first internode or above, it was considered a case of stalk lodging.

Determination of breaking strength of stalks. The breaking strength and the breaking point of each of the stalks of a number of hills were determined weekly from boot stage to maturity. A paper clip was placed at a point on the stalk one and a half feet from the ground. The spring balance was hooked to the paper clip and a circular downward pull was given to the stalk until it broke, after which the reading was taken. This method was used so that the stalk would break at its weakest point. Ten hills taken at random from each variety were used to determine the number of stalks that broke and those that did not break.

Morphological and plant characters. For both lowland and upland varieties, observations were made on the following morphological characters of the stalk at maturity: (1) weight of 5-cm. length from the second internode without sheath—twenty samples were taken, one from a primary tiller of each hill; (2) length of the first two internodes—measurements were made from the primary tiller of each hill; (3) diameter of first internode—samples were taken as in (1); (4) thickness of wall of culm—40 microns of the second internodes of primary tillers were sectioned with a microtome; and (5) thickness of layer of sclerenchyma cells—some materials from (4) were used.

The following varietal plant characters were also studied: (1) length of panicle exsertion, (2) length of panicle, (3) weight of panicle and (4) habit of growth. Measurements for (1), (2), and (3) were taken from the primary tiller of each hill.

Determination of pulling strength. The varietal resistance to pulling was determined by applying a vertical pull. All the tillers of a hill were tied together with a rope at a point about 20 cm. from the ground. The rope was then hooked to the pulling strength apparatus and the pull applied until the whole hill was uprooted. De-

terminations were made at three periods of plant growth—boot stage, heading, and maturity. Ten hills taken at random were used for each variety. As the number of tillers in each hill varied considerably, the pulling strength of the varieties were computed on a per-tiller basis.

Root development and penetration. To study the downward and horizontal penetrations of the roots individual hills of upland varieties were balled and the soil was washed away with water to expose the roots. No balling was necessary for lowland rice. The number and length of root was noted.

Depth of surface soil in lowland rice paddies and root lodging. In the paddies planted to Milfor 6 (2), a variety resistant to lodging, spots where the plants root-lodged badly were marked. The depth of the surface soil of these spots was determined after harvest time when the field was dry.

EXPERIMENTAL RESULTS

Root and stalk lodging. It was often difficult to distinguish between root and stalk lodging particularly when lodging occurred at a point close to the ground and when the leaf sheaths were loosely covering the stem. Following stalk lodging, numerous tillers emerged within a week, whereas following root lodging, only a few tillers were produced and their emergence was very much delayed.

Almost all the lodging of the upland varieties was stalk lodging. But majority of the lodging of the lowland varieties was root lodging (fig. 1). There were few instances of both root and stalk lodging because if a plant stalk-lodges, it is unlikely that it will root-lodge and conversely.

Breaking strength of stalks at weekly intervals from boot stage to maturity. As shown in table 1 and figure 2, the breaking strength of stalks of the upland varieties varied from boot stage to maturity. The general trend was for the breaking strength to progressively increase from the first to fourth or fifth week and then abruptly decline in the sixth week. The peak for Milfor 6 (1), however, was in the third week. The maximum for Ac 360 Ptb 10 was in the first week with a second slightly lower peak in the fifth.

Several significant differences were obtained by comparing varieties. There were eleven significant comparisons at the 1 per cent level and one at the 5 per cent level during the first week of observation. From three to five weeks after boot stage, Milfor 6 (1) had a

(a)

(b)

Fig. 1.—(a) Root lodging in lowland rice (Variety Milfor 6[2]). (b) Stalk lodging in lowland rice (Variety Milfor 6[2]).

TABLE 1.—*Mean breaking strength of stalks of upland rice varieties at weekly intervals from boot stage to maturity* [a]

VARIETY	STANDABILITY	BREAKING STRENGTH PER TILLER IN GRAMS					
		1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.
1. Milfor 6 (1)	Non-lodger	184	274	446	278	453	200
2. Milfor 6 (2)	Non-lodger	150	262	314	334	409	138
3. Palawan	Non-lodger	224	190	194	310	352	94
Mean		187	242	318	307	404	144
4. Azucena	Medium lodger	260	151	201	425	475	117
5. Fortuna	Medium lodger	194	194	182	245	381	126
6. Guinata	Medium lodger	198	166	167	270	252	74
Mean		217	170	183	313	369	106
7. Sinaba	Lodger	136	91	100	93	182	74
8. Lady Wright	Lodger	108	109	153	107	272	83
9. Ac 360 Ptb 10	Lodger	150	59	50	65	112	Lodged
Mean		131	86	101	88	192	78

[a] Each value is the mean breaking strength per tiller of 10 hills.

significantly stiffer straw than Milfor 6 (2). This indicates that for breeding purposes, Milfor 6 (1) is a more desirable source of resistance to lodging than Milfor 6 (2). Similarly, when each of the lodging varieties was compared to varieties of the other groups, significant differences were obtained, except during the first week after boot stage.

However, when the non-lodging, medium-lodging, and lodging varietal groups were compared, the results showed no significant difference. This indicates that some varieties classified as medium lodger or lodger sometimes gave equal or higher readings in breaking

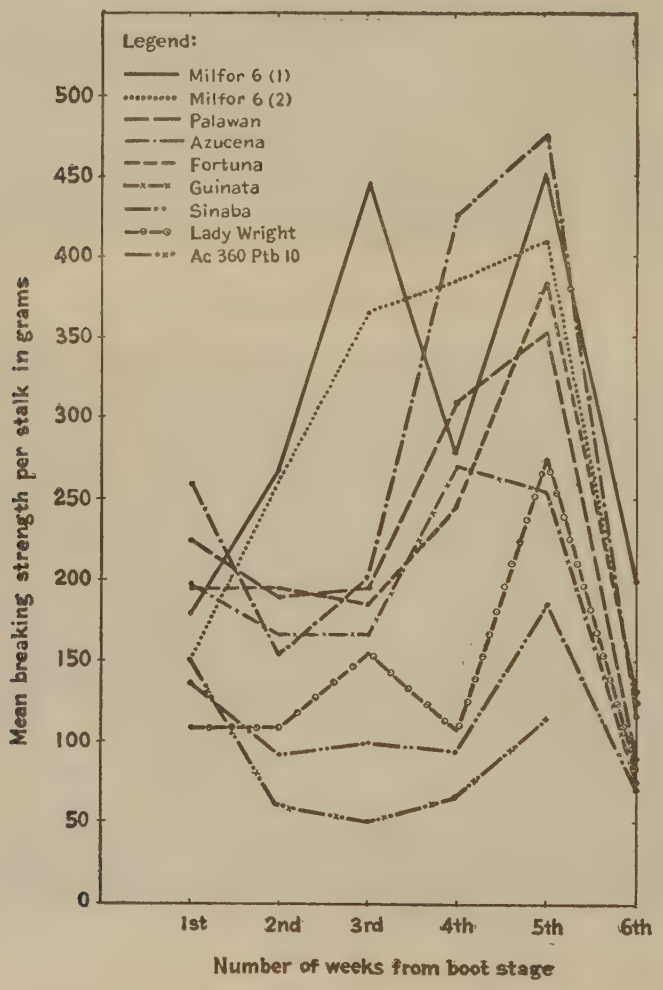

Fig. 2.—Breaking strength of stalks at weekly intervals from boot stage to maturity of upland rice varieties.

strength than non-lodging varieties. Generally, however, the non-lodging group gave higher readings than the medium-lodging group, and the medium-lodging group, higher readings than the lodging group.

During the growing period of the upland varieties only Lady Wright and Ac 360 Ptb 10 lodged at about maturity. There was little lodging because the growing season was extremely dry.

After the fourth week the breaking strength of the stalks of all varieties dropped. At this stage the grains were already full and hard although the glumes were still green.

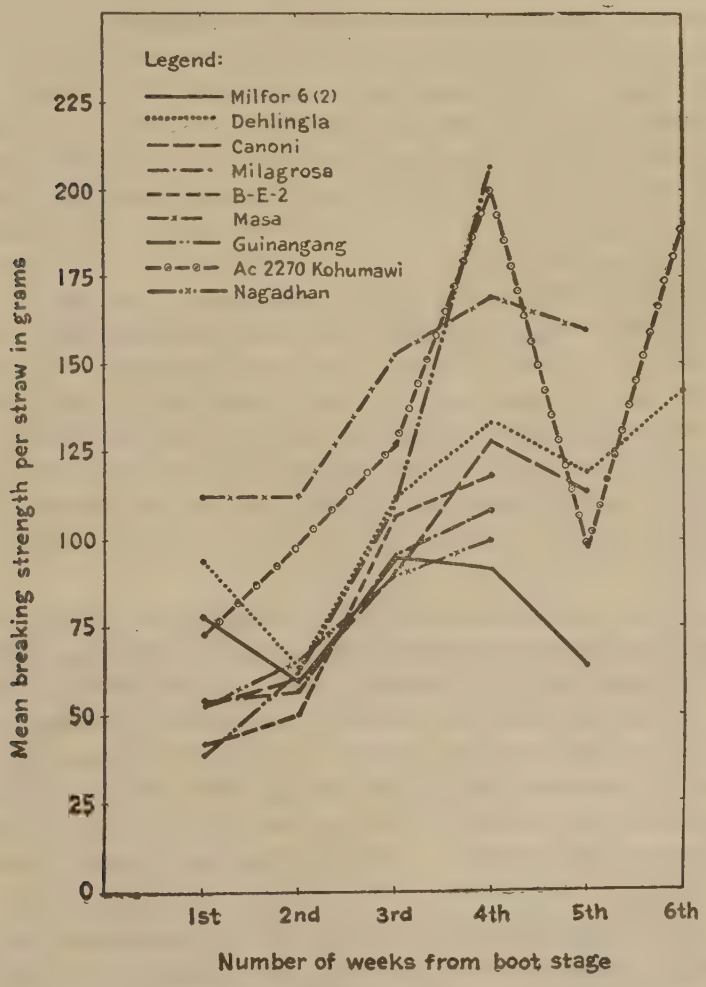

Fig. 3.—Breaking strength of stalks at weekly intervals from boot stage to maturity of lowland rice varieties.

Compared with those of the upland varieties, the breaking strength readings of the lowland varieties were relatively lower as shown in table 2 and figure 3. The highest breaking strength reading (206 g., fourth week) was for Guinangang, a lodger, and the lowest reading (38.0 g., first week) was also for Guinangang. From boot stage to maturity the breaking strength of the stalks of all varieties, with one minor exception, gradually increased, attaining maximum value during the fourth week and from then on dropped gradually.

The average breaking strength for each tiller of the lowland varieties in four periods of observation are presented in table 2. The computed t-values for the comparisons of non-lodgers with lodgers, medium lodgers with lodgers, and non-lodgers with medium lodgers were insignificant. However, varietal differences in breaking strength were obtained between the different varieties. Five comparisons between the non-lodging and lodging groups were significant at the 1 per cent level and five at the 5 per cent level. At the 5 per cent level there were three significant comparisons two weeks after boot stage, and three during the third week. During the fourth week after boot stage five significant comparisons at the 1 per cent level, and two at the 5 per cent level were obtained. The increase in the number of significantly different varieties at maturity (four weeks after boot stage) compared with the increase in the second and third weeks, may have been due to the fact that some varieties at maturity had stiffer straw because their stalks were still green, and the others had weaker straw because their stalks were already dry.

When the non-lodging, medium lodging, and lodging lowland varietal groups were compared, there was no significant difference among the groups. The general trend among upland varieties in which those with better standability had higher breaking strength values, did not hold true for lowland varieties. As shown in table 2, the lodging varieties had higher readings than Milfor 6 (2), a variety resistant to lodging. The results indicate that stiffness of straw is not a safe measure of standability for lowland varieties.

It was also observed that the lowland varieties lodged earlier than the upland varieties (tables 1 and 2). The number of days from boot stage to maturity was about 38 for lowland and about 45 for upland.

TABLE 2.—*Mean breaking strength of stalks of lowland rice varieties at weekly intervals from boot stage to maturity* [a]

VARIETY	STANDABILITY	BREAKING STRENGTH PER TILLER IN GRAMS					
		1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.
Milfor 6 (2)	Non-lodger	77	59	95	91	64	Harvested
Dehlingla	Non-lodger	94	63	112	134	110	142
Canoni	Non-lodger	52	59	91	127	118	Harvested
Mean		74.3	60.3	102.6	117.5	100.3	
Milagrosa	Medium lodger	54	57	95	109	Lodged	Harvested
B-E-2	Medium lodger	41	50	106	113	Lodged	Harvested
Masa	Medium lodger	112	112	152	168	159	Harvested
Mean		69	73	118	130		
Guinangang	Lodger	38	62	110	206	Lodged	Harvested
Ac 2270 Kohumawi	Lodger	72	98	128	200	97	190
Nagadhan	Lodger	52	64	90	100	Lodged	Harvested
Mean		54.0	74.7	109.3	168.7		

[a] Each value is the mean breaking strength per tiller of 10 hills.

Relation between stalk lodging and anatomical characters. Several anatomical characters of the stalks were studied to find out if there was any relationship between them and stalk lodging.

a. *Weight of 5-cm. length of second internode.* Of the upland rice varieties, Milfor 6 (1) gave the highest weight (0.97 gram) and Ac 360 Ptb 10, the lowest (0.74 gram). However, the t-test did not show any significant difference between the means of the two varieties mentioned. None of the comparisons of the varieties was significant.

Of the lowland groups, only Milfor 6 (2), Canoni, and Masa were studied because the rest lodged at maturity, resulting in the rotting of the second internode. The weight of the second internode of the three varieties was practically the same. The comparisons between their means were all insignificant.

b. *Length of the first two internodes.* With the exception of Sinaba and Ac 360 Ptb 10, the first two internodes in upland varieties were longer with weaker straws and shorter with stiffer straws (table 3). Milfor 6 (1) and Milfor 6 (2) differed significantly from Fortuna, Guinata, and Lady Wright; Palawan from Guinata and Lady Wright (table 3a). The length of the first two internodes of the three lowland varieties did not follow the trend of the upland varieties. None of the comparisons between varietal means was significant.

TABLE 3.—*Length of the first two internodes of primary tillers of upland rice varieties at maturity*

VARIETY	LENGTH IN CM. [a]
1. Milfor 6 (1)	7.2
2. Milfor 6 (2)	6.8
3. Palawan	8.3
4. Azucena	14.9
5. Fortuna	14.5
6. Guinata	17.6
7. Sinaba	15.0
8. Lady Wright	19.5
9. Ac 360 Ptb 10	9.7

[a] Mean of 20 samples, each sample taken from a primary tiller of a hill.

TABLE 3a.—*Values of t for comparison between means (length of the first two internodes of primary tillers of upland rice varieties at maturity)*

VARIETY	MILFOR 6 (2)	Palawan	Azucena	Fortuna	Guinata	Sinaba	Lady Wright	Ac 360 Ptb 10
Milfor 6 (1)	0.12	0.33	1.70	2.13 [a]	2.41 [a]	1.89	2.41 [a]	0.54
Milfor 6 (2)	—	0.42	1.69	2.12 [a]	2.40 [a]	1.87	2.44 [a]	0.61
Palawan		—	1.46	1.70	2.16 [a]	1.56	2.19 [a]	0.30
Azucena			—	0.084	0.50	0.18	0.76	0.92
Fortuna				—	0.68	0.11	0.94	1.02
Guinata					—	0.51	0.32	1.32
Sinaba						—	0.78	1.48
Lady Wright							—	1.63

[a] Significant.

c. *Diameter of first internode.* The diameter of the first internode of upland rice varieties apparently was related to stiffness of straw. The non-lodgers and lodgers had the least diameter and the medium lodgers had the largest diameter. Only mean differences of Ac 360 Ptb 10 vs. Azucena, and Ac 360 Ptb 10 vs. Fortuna were significant. The diameter of the first internode of the three lowland varieties was not related to stiffness of straw.

d. *Thickness of wall of culm and sclerenchyma cells.* Figure 4 shows the cross section of the culm at the second internode of Milfor 6 (2) and of Nagadhan. Compared with Nagadhan, the culm of Milfor 6 (2) had thicker walls, smaller sclerenchyma cells with thicker cell walls, and less intercellular spaces. The same structural comparison is true between Milfor 6 (1) and Ac 360 Ptb 10, both upland rice varieties

Relation between plant characters and stiffness of straw. Of the 117 comparisons made for length of panicle exsertion, length of panicle, and weight of panicle, statistically significant differences for eight variety pairs were revealed. Since this is only slightly more than 6, the number expected as a result of chance, it seems reasonable to conclude that there were no significant differences.

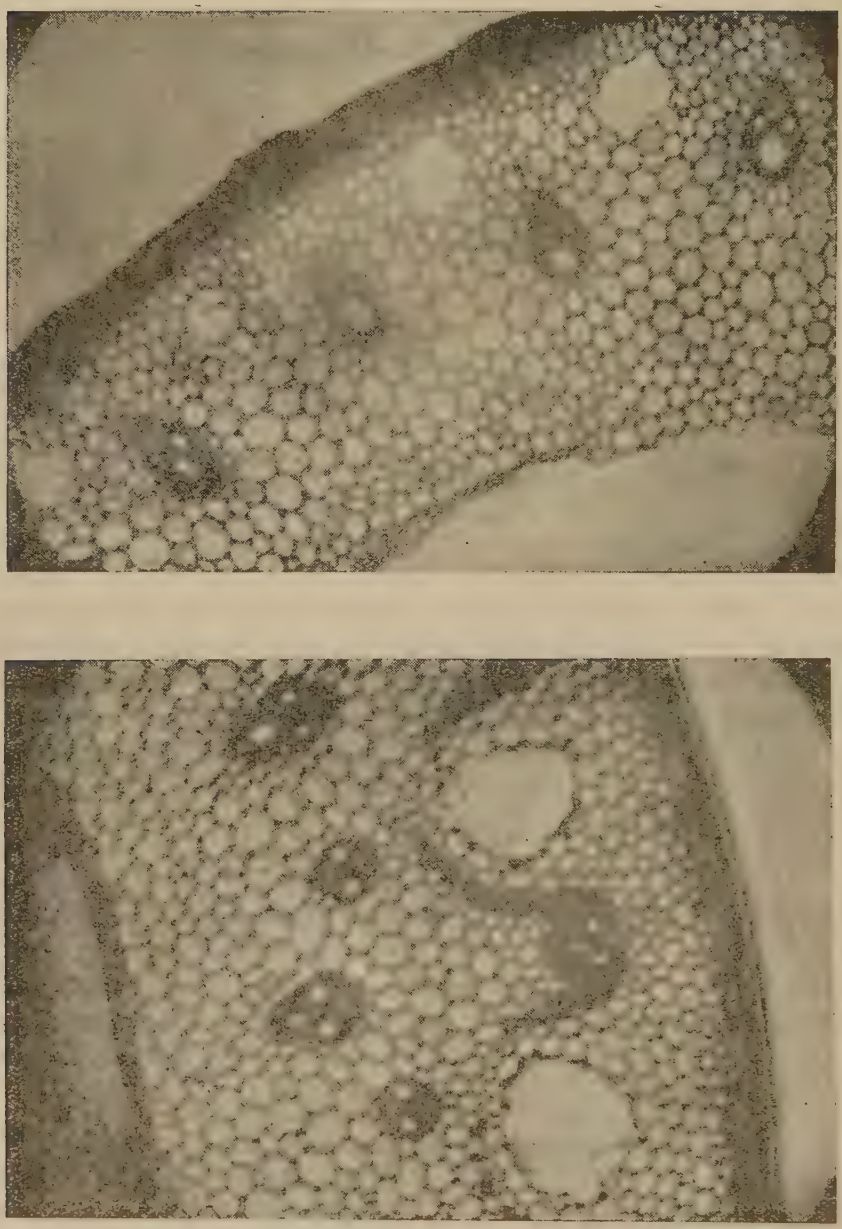

Fig. 4.—Cross section of culm at second internode. Upper, Milfor 6(2); lower, Nagadhan.

The different lowland rice varieties have the following habit of growth:

Milfor 6 (2)	Upright
Dehlingla	Semi-spreading
Canoni	Semi-spreading
Milagrosa	Semi-spreading
B–E–2	Semi-spreading
Masa	Semi-spreading
Guinangang	Spreading
Ac 2270 Kohumawi	Spreading
Nagadhan	Spreading

The habit of growth of the upland rice varieties are given below:

Milfor 6 (1)	Upright
Milfor 6 (2)	Upright
Palawan	Semi-spreading
Azucena	Semi-spreading
Fortuna	Semi-spreading
Guinata	Semi-spreading
Sinaba	Spreading
Lady Wright	Spreading
Ac 360 Ptb	Spreading

The two strains of Milfor 6, which are the most resistant to lodging among the varieties, had a very distinct upright growth; they grew so close to each other that the base was practically a tight bundle. The semi-spreading varieties, although with upright stalks, were not compact at the base. With the spreading ones, only the primary tillers were erect; the rest were reclining.

In most of the upland rice varieties, the pulling strength gradually decreased from the pre-heading period to maturity (table 4). The non-lodgers and lodgers had lower pulling values than the medium lodgers. None of the comparisons between the means of the groups was significant. This was because most of the lodging observed in upland rice was stalk and not root lodging.

With lowland rice differences between the pulling strength of varieties from different groups were insignificant (table 5).

TABLE 4.—*Pulling strength of upland rice varieties* [a]

VARIETY	STANDABILITY	PULLING STRENGTH PER TILLER IN LBS.		
		Pre-heading	Heading	Maturity
Milfor 6 (1)	Non-lodger	2.3	2.6	2.1
Milfor 6 (2)	Non-lodger	3.2	2.8	3.2
Palawan	Non-lodger	7.1	6.2	5.6
Mean		4.2	3.8	3.6
Azucena	Medium lodger	8.2	7.6	5.8
Fortuna	Medium lodger	9.0	6.3	3.7
Guinata	Medium lodger	8.4	5.9	6.6
Mean		8.5	6.6	5.4
Sinaba	Lodger	4.4	3.6	1.8
Lady Wright	Lodger	3.9	3.3	3.3
Ac 360 Ptb 10	Lodger	2.6	1.8	1.5
Mean		3.6	3.6	2.2

[a] Based on pulling strength of 10 hills per variety.

Dehlingla, a non-lodger, lodged at heading because it was planted in a deep portion of the field. Canoni and Ac 2270 Kohumawi had brittle stalks which with a little pull broke easily.

TABLE 5.—*Pulling strength of lowland rice varieties* [a]

VARIETIES	STANDABILITY	PULLING STRENGTH PER TILLER IN KG. LBS.		
		Pre-heading	Heading	Maturity
Milfor 6 (2)	Non-lodger	3.4	3.8	3.5
Dehlingla	Non-lodger	7.2	Lodged	Lodged
Canoni	Non-lodger	[b]	[b]	[b]
Milagrosa	Medium lodger	3.2	Lodged	Lodged
B-E-2	Medium lodger	3.1	3	3.2
Masa	Medium lodger	6.0	8.3	8.4
Guinangang	Lodger	3.1	2.9	Lodged
Ac 2270 Kohumawi	Lodger	7.6	[b]	[b]
Nagadhan	Lodger	4.8	4.1	3.9

[a] Based on pulling strength of 10 hills per variety.
[b] The individual hills could not be pulled because of the brittleness of stalk.

Root development and penetration. In general, the non-lodging upland rice varieties had more roots, broader horizontal and deeper vertical penetrations than the medium lodgers and the lodgers. Among the groups of upland rice varieties the difference was more pronounced in number of roots than in either vertical or horizontal root penetration. The non-lodgers were higher than the medium lodgers in number of roots, horizontal penetration, and vertical penetration by 36.7, 0.6 cm., and 1.1 cm., respectively; the medium lodgers in turn were higher than lodgers in the same root characters.

by 32.0, 8.4 cm., and 4.1 cm., respectively. However, these differences among groups cannot explain the cause of lodging in upland varieties since there was more stalk lodging than root lodging.

With the lowland varieties, there were inconsistent differences among groups in both horizontal and vertical root penetration. There was so much variation in number of roots within each group, however, that no conclusion was arrived at as to the relationship between number of roots and standability of lowland rice varieties.

Depth of surface soil in lowland rice paddies and root lodging. In one field of Milfor 6 (2) grown in the wet season of 1955, there were two spots where the plants root-lodged badly. One spot had an area of 18 sq. m. and the other about 12 sq. m. In another field where Milfor 6 (2) was planted 10 x 10 cm., there was also a spot of about 11 sq. m. where the plants lodged seriously. When the depth of surface soil of these spots was determined it was found that it ranged from 13 to 20 inches deep, whereas the surface soil surrounding these spots where there was no lodging was from 9 to 12 inches deep.

DISCUSSION

In this study, the nature of lodging in both upland and lowland rice was studied to determine a reliable and simple method of finding resistance to lodging in breeding for good standability.

Salmon, as quoted by Seko (1954), found varietal differences in breaking strength of wheat culms. The culms of lodging varieties are easier to break than those of non-lodging varieties. This was confirmed by Atkins (1938) who found that the correlation coefficients for lodging and breaking strength and the weight per unit length and lodging were both significant. On the other hand, Clark and Wilson (1933) found no correlation between breaking strength and lodging in wheat.

Breaking strength of stalk could be a good measure of resistance to lodging in upland rice. Breaking strength readings taken during the fourth week from boot stage showed best results because at this time differences between the non-lodgers, medium-lodgers and lodgers were most pronounced.

If testing for resistance to lodging should be undertaken for upland rice and breaking strength should be used as a measure, it will not be advisable to assign fixed breaking strength values to indicate a certain degree of resistance to lodging. Environmental conditions which change from season to season cause changes in the

breaking strength values of varieties. A better method is to compare the breaking strength of the variety whose standability is to be determined, with the breaking strength of a variety with a known standability and which is grown side by side with the former. Breaking strength of the straw, however, can not be used to indicate standability for lowland varieties which are mostly root lodgers.

Bartel (1937) reported that the weight of head, and weight and elasticity of culms should also be considered for a complete evaluation of the relation between breaking strength and lodging, especially as the plants reach maturity. This, however, did not apply in both upland and lowland rice.

The anatomical character that could show straw stiffness for upland rice is the length of the first two internodes at which the bending or breaking of the stem normally occurs. The shorter this region of the stem, the thicker are the culm walls, which means more mechanical strength for the straw.

Ramiah and Dharmalingam (1934) reported that in lodging and non-lodging types of rice there is a close relationship between thickness of culm wall of the second internode, especially of the sclerenchyma layer of cells with thick walls, and stalk lodging. Garber and Olson (1919) found a positive correlation between lodging in oats and thickness of the sclerenchyma cell wall.

Kato and Yasuda, as cited by Seko (1954), found that the major factors for lodging in rice plants are the following: (1) large spaces in leaf sheath and hollow center of culms, (2) large parenchymatous cells of leaf sheath and culms, thin membranes, large intercellular spaces, small area of mechanical tissue composed of sclerenchyma cells, few cells, and thick membranes, and (3) large bundle sheath cells and thick cell membranes.

A simple and practical way of judging standability is by noting the growth habit of plants. In general those resistant to both kinds of lodging had a very erect growth, with tillers compact at the base, and with leaf sheaths permanent and tight on the stems.

Ramiah and Rao (1953) reported that non-lodging varieties had strong and persistent leaf sheaths which completely shroud the lower internodes and act as effective support. Upright growth of tillers is not enough. They must be growing close to each other generally. The non-lodgers are not the heavy tiller types.

Apparently there is no variety which is strictly non-lodging. Any variety will lodge if given the growing conditions suitable to lodging.

Milfor 6 (2) a strictly non-lodger, lodged when grown in poorly drained fields, the surface soil of which is 13 to 20 inches deep. Such conditions provide poor mechanical support for the stalks; hence, lodging occurs.

LITERATURE CITED

ATKINS, I. M. 1938. A simplified method for testing the lodging resistance of varieties and strains of wheat. Jour. Amer. Soc. Agron. 30: 309-313.

BARTEL, A. J. 1937. Changes in breaking strength of straw of wheat varieties from heading to maturity. Jour. Amer. Soc. Agron. 29: 153-156.

CLARK, E. R. and H. K. WILSON. 1933. Lodging in small grains. Jour. Amer. Soc. Agron. 25: 561-572.

GARBER, R. J. and P. J. OLSON. 1919. A study of the relationships of some morphological characters to lodging in cereals. Jour. Amer. Soc. Agron. 11: 173-186.

RAMIAH, K. and S. DHARMALINGAM. 1934. Lodging of straw and its inheritance in rice. Indian Journal of Agricultural Science 4: 880-890.

RAMIAH, K. and M. B. V. RAO. 1953. Rice breeding and genetics. Indian Council of Agricultural Research Scientific Monograph No. 19.

SEKO, HIDEO. 1954. Lodging in rice plants and its testing method. Fifth Meeting of the International Rice Commissions Working Party on Rice Breeding Reports 2: 185-198.

THE EFFECT OF TWO HERBICIDES ON RICE PLANTS SPRAYED AT DIFFERENT STAGES OF GROWTH [1]

R. K. DE LA FUENTE, S. N. FERTIG and P. A. LLENA [2]

WITH ONE TEXT FIGURE

As regards reaction to herbicides, the life history of the Milfor 6 rice variety can be divided into four stages: (1) a susceptible seedling period which extends from germination to that state when tillers are about ninety per cent of the maximum; (2) a tolerant stage from the upper limit of the first stage up to just before the initiation of the floral bud; (3) a short susceptible period from the initiation of the floral bud to about the dough stage of the grain; (4) another tolerant stage from the dough stage to the maturity of the grain.

Except for the plants sprayed at germination, mortality due to spraying was not observed.

Because there was no significant difference in weight of a hundred seeds between any two treatments, differences in yield among treatments must have been caused by an inhibition of tillering in some.

Susceptibility of a plant varies with the stage of development, so that a plant "resistant" to herbicides may at one stage or another succumb to it if applied at the less tolerant stage. Dersheid *et al.* (1953) who worked with oats and barley concluded that the most important factor affecting injury is the stage of growth when treatment is applied.

The purpose of this study was to find the relative resistance of different stages of development of the rice plant to sprays of 2,4-dichlorophenoxyacetic acid (2,4-D), and 2,4,5-trichlorophenoxypropionic acid (Kuron).

MATERIALS AND METHODS

Pot experiment

Pots 20 cm. in top diameter and 18 cm. in bottom diameter were filled with clay loam soil screened through a one-centimeter sieve. Four to six Milfor 6 seeds previously soaked in water for two days were planted in each pot on January 19, 1956. Two days later, when the coleoptile was coming out, the germinating seeds were thinned down to one in each pot. Plants sprayed at this stage are designated in this paper as "sprayed at zero days old." Other plants in quadru-

[1] Central Experiment Station Contribution No. 1918. A part of Research Project No. 528.

[2] The authors acknowledge the assistance of Mr. Jose M. Lasala in conducting this project.

plicate were sprayed with herbicides at 10, 20, 30, 40, 50, 60 and 70 days after the first spraying.

Two herbicides, 2, 4-dichlorophenoxyacetic acid (2,4-D), and 2, 4, 5-trichlorophenoxypropionic acid (Kuron), were used at concentrations of three-fourths, and one and one-half pounds (acid equivalent) per acre. A knapsack sprayer operated at 40 pounds pressure per square inch and a speed of two miles per hour delivered 15 gallons of spray per acre. A rectangular wooden frame, the sides of which were covered with manila paper separated the lot being sprayed from the others during spraying.

Except for the herbicide treatments all the pots received the same care and management.

Field experiment

The soaked seeds were planted in a seedbed and transplanted twenty days later in plots of 6 × 2 meters at 50 cm. between rows and 15 cm. between hills. The treatments consisted of spraying the same herbicides, 2, 4-D and Kuron at the rate of three-fourths pound per acre. As in the pot experiment the knapsack sprayer was operated at the same pressure and mileage. The spraying of the 40-day old plants started 20 days after transplanting and continued up to 130 days of age, just four days before harvesting.

The experimental layout was a completely randomized design, each treatment consisting of four replications.

In both experiments weekly tiller counts and height measurements were taken.

RESULTS AND DISCUSSION

Mortality and morphological abnormalities of plants as affected by age of spraying. In fourteen sprayings mortality cases were observed only on plants sprayed during germination. Only two survived of those sprayed with the lower concentration of 2, 4-D, and one died of the four sprayed with the higher concentration. The lower concentration of Kuron did not kill any plant while the higher concentration resulted in a 100 per cent mortality.

When the germinating seeds were sprayed on January 29, 1956 the coleoptile was about a millimeter. This coleoptile grew up to about a centimeter or more, without the first leaf coming out. On the other hand, the control plants on the third day of planting had the first leaf coming out of the coleoptile. It was also observed that the roots of the control plants had already penetrated the soil at the time the first leaf was coming out, while most of the germinating

seeds sprayed with the herbicides did not develop roots until after a week. There were also cases where the first leaf came out without the radicle showing signs of activity. Where the radicle was completely inhibited the seedling did not live long.

Death of seedlings sprayed with 2, 4-D was rapid, occurring in about three days, while death caused by Kuron was slow, occurring after more than a week and in two seedlings, the first leaf was not followed by another although the plant lived about three weeks.

Spraying at other stages of growth had visible effects on the plants though in no case was the injury so severe as to result in death.

About 50 per cent of the plants which exhibited abnormalities were those sprayed ten days after germination. At this age the plant had about two to three leaves but no tiller yet. Three to four days after spraying the plants developed an enlarged basal portion followed by bending towards the side opposite that taken by the old coleoptile. On most plants the abnormal leaf was very seldom followed by another leaf. This was due to the extremely small and non-flexible tissues of the abnormal leaf which made it very hard for the next leaf to go through, resulting either in the breaking of the bud through the stem or more often, the development of dormant buds.

Twenty days after spraying the following leaf abnormalities were observed: (a) the "onion leaf" which is discussed fully by Kaufman (1955); (b) the apparent fusing of two leaves; and (c) the leaf with its midrib nearer one side of the leaf margin. The last two although expanded are much narrower than the normal leaf and are rare. Almost all of the leaf abnormalities developed in plants sprayed with 2-4-D.

Plants sprayed with the higher concentration of Kuron showed an almost complete non-elongation of the internodes and developed small leaves that were generally rolled in. Those sprayed with 2, 4-D at 110 days of age or at the dough stage of the grain showed an enlargement and bending of the node nearest the panicle (fig. 1). The herbicides probably caused the node cells to be more elastic, thus causing bending following the weight of the panicle. Plants sprayed at 100 days of age did not show this because the panicle had no weight yet; and by the time the grains became heavy enough, the activity of the herbicide was already lost. Very few plants exhibited bending when sprayed at 120 days of age, probably because the node cells at this stage were not as receptive as when they were at 110 days.

Fig. 1.—Upper panel, rice plants at about the dough stage of the grain showing the effect of 2, 4-D spraying. Note the bending and enlargement of the node of the two sprayed plants at the right in magnified photo, lower panel.

Height and number of tillers per plant as affected by age of spraying. The growth curve for the control plants was very similar to the sigmoid type of curve. The younger the plants when sprayed the greater was the deviation from this type of curve. Treatments that were badly affected were those sprayed from germination up to one month old. Some of the other cultures were also affected by the spray as shown by the "flattening of the curve" at one time or another compared with the control. Recovery by the other plants was

however, much faster exceeding even the control in height after getting over the bad effects of the herbicide.

Response of the plants to the different herbicides and concentrations was practically the same.

Parallel with the effect of the herbicide on the height of the plants was the adverse effect on tiller development when the spray was applied during the early seedling stages.

Most probably no other part of the growing rice plant is more closely related to the total yield of grains than the number of tillers especially those that ultimately head.

Some plants sprayed with 2,4-D at both concentrations, and with Kuron at low concentration were seriously injured like those sprayed at germination, at 20 and 30 days old. However, recovery after the loss of herbicide activity in these ten-day old plants was much faster and the final number of tillers developed even exceeded those of the control. The treatment with the higher concentration of Kuron did not give the same reaction showing that this herbicide is more harmful than 2,4-D at the early stage of growth on the Milfor 6 variety. The nature of the above response is not very clearly understood.

Beginning at forty days of age, the plant which had about ninety per cent of its maximum tillers was already resistant to sprays of both herbicides at the two concentrations tested (table 4).

This observation, however, did not hold true in the field experiment. The number of tillers of plants sprayed at forty and fifty days of age were seriously affected. Chronological age seemed to be a poor basis for determining the stage tolerant to the spray. The physiological age may be a better criterion.

Table 1 shows that the potted plants as mentioned earlier had already about ninety per cent of the final number of tillers visible; in the field plants of the same age had only about one-fourth.

TABLE 1.—*Comparative number of tillers of directly-planted and transplanted rice plants showing non-relationship between chronological age in the early stages of growth, and stage of development of the tillers*

Age of plant (directly planted)	21	28	35	42	49	56	63	70
No. of tillers	1.6	2.7	4.7	9.0	10.2	10.7	11	11
Per cent based on final number	14.5	24.5	42.7	81.8	92.7	97.2	100	100
Age of plant (transplanted)	49	56	63	70	77	85	92	99
No. of tillers	4.8	9.2	12.2	12.7	14.0	14.2	14.2	14.2
Per cent based on final number	33.8	64.8	85.9	89.4	98.6	100	100	100

Ninety per cent of the tillers of the transplanted plants became visible at seventy days of age, and like the observation in the pot experiment, spraying at this stage of development did not affect the final number of tillers that were initiated.

With wheat and barley, the tillering period is considered a tolerant stage (Leopold, 1955). Results of this experiment and that of Arai and Kawashima (1954) show that rice is very susceptible during this period.

Yield of grains as affected by stage of spraying. Yield differences between the different stages of growth sprayed with 2,4-D were found to be insignificant; the trend in yield decrease, however, was the same as in those of the Kuron-sprayed plants. The Kuron-sprayed plants were more responsive to treatment both to the higher and lower concentrations of the herbicide and to both, pot and field experiments.

TABLE 2.—*Yield of plants in grams per hill in pot experiment*

AGE AT SPRAYING	¾ 2,4-D[a]	1½ 2,4-D	¾ KURON	1½ KURON
0	15.23	18.01	20.08	0
10	41.41	40.91	42.45	13.64
20	29.85	28.80	13.04	13.46
30	30.25	41.95	32.10	23.25
40	26.65	31.00	50.08	38.18
50	34.67	26.31	30.72	37.97
60	32.71	45.44	33.32	36.25
70	39.69	30.11	35.41	26.31
Control	30.57			
SMD 5% (T)	b	b	15.0	14.30

[a] Rate is in pounds per acre.
[b] Insignificant

TABLE 3.—*Yield of grains in cavans per hectare in field experiment*

AGE WHEN SPRAYED	CONTROL	40	50	60	70	80	90	100	110	SMD 5% (T)
3/4 2,4-D	30.37	28.14	27.86	40.08	34.74	45.30	29.38	21.02	23.15	[a]
3/4 Kuron		15.48	18.77	32.86	40.48	39.75	39.18	29.60	28.49	16.62

[a] Insignificant

Both herbicides seriously affected the development of tillers in the early stages of growth but the plants sprayed with 2,4-D recovered and initiated tillers to almost the same number as those of the control (table 4). The Kuron-sprayed plants likewise initiated tillers, but recovery was not as rapid as that of the 2,4-D sprayed plants. Kuron seemed to be more persistent in the plant body than

2,4-D as evidenced by the presence in tillers of fasciation (abnormal enlargement and flattening of stems) up to maturity of the grains. The decrease in grain yield is a direct effect of the herbicide on its inhibition on tiller development. Differences between treatments of the weight of 100 seeds were found to be insignificant.

TABLE 4.—*Effect of herbicides sprayed at different stages of growth on the development of tillers*

AGE OF SPRAYING	TREATMENT	21	35	49	63	77	91
	Control	1.6	4.7	10.2	11.0	11.0	
	3/4 2,4-D	1.0	2.0	3.5	6.5	10	10.5
	3/4 Kuron	1.0	1.0		2.7	6.5	10.5
0	1–1/2 2,4-D	1.0	1.2	1.3	4.0	8.6	9.3
	1–1/2 Kuron	1.0	0	0			
	3/4 2,4-D	1.0	2.0	5.0	10.5	16.2	16.7
	3/4 Kuron	1.0	2.0	5.0	10.2	12.0	13.5
10	1–1/2 2,4-D	1.0	1.5	3.7	9.5	12.7	12.7
	1–1/2 Kuron	1.0	1.0			3.5	5.0
	3/4 2,4-D	1.0	1.7	2.7	7.0	9.7	10.0
	3/4 Kuron	1.0	2.0	2.2	3.5	4.2	4.7
20	3/4 2,4-D	1.0	1.0	2.3	4.6	8.3	8.3
	1–1/2 Kuron	1.2	1.7		3.5	6.5	6.5
	3/4 2,4-D	1.2	4.0	4.5	7.5	9.7	10.2
	3/4 Kuron	1.0	3.5	4.2	5.2	5.5	6.2
30	1–1/2 2,4-D	1.7	3.7	3.7	6.2	7.7	9.0
	1–1/2 Kuron	1.7	4.5	5.7	6.2	6.2	6.2
	3/4 Kuron	1.5	5.0	10.2	10.5	10.5	10.5
	1–1/2 2,4-D	2.0	8.0	16.0	16.0	16.0	16.0
40	1–1/2 2,4-D	1.2	5.5	9.5	10.5	10.5	10.5
	1–1/2 Kuron	1.2	5.2	12.0	12.0	12.0	12.0
	3/4 Kuron	4.7	12.3	13.7	13.7	13.7	
	3/4 Kuron	4.0		11.0	11.0	11.0	1.0
50	3/4 Kuron	4.5	12.0	12.0	12.0	12.0	1.0
	3/4 2,4-D	6.0	15.0	15.7	15.7	15.7	1.6
	3/4 2,4-D	1.2	4.7	9.5	11.2	11.2	11.2
	3/4 Kuron	1.0	5.2	10.7	11.7	11.7	11.7
60	3/4 2,4-D	1.5	5.7	14.5	17.7	17.7	17.7
	3/4 Kuron		6.2	13.7	13.7	13.7	13.7
	3/4 Kuron	1.5	3.7	10.5	13.0	13.5	13.5
	1–1/2 2,4-D	1.2		12.5	14.5	14.5	14.5
70	1–1/2 2,4-D	1.0		10.2	10.2	11.7	11.7
	1–1/2 2,4-D	1.3	6.0	12.2	12.2	12.2	12.2

[a] The mother plant was counted as one tiller.

Of the different stages sprayed with the lower concentration of Kuron, only those sprayed at twenty days old were significantly decreased at the five per cent level. At the higher concentration the yield of the plant sprayed at ten and twenty days of age was significantly decreased at five per cent level (table 2).

The significant decrease in yield caused by Kuron, however, is found to be true only if applied when tiller development is not yet complete. If the chemical is applied when the number of visible tillers is about ninety per cent of the total number that will be initiated, the yield is not decreased anymore. In terms of yield, this resistant stage is extended up to before the initiation of the floral bud, at which stage yield is again liable to be decreased by the herbicide (fig. 2). At this second stage of susceptibility 2,4-D tends to decrease the yield more than Kuron.

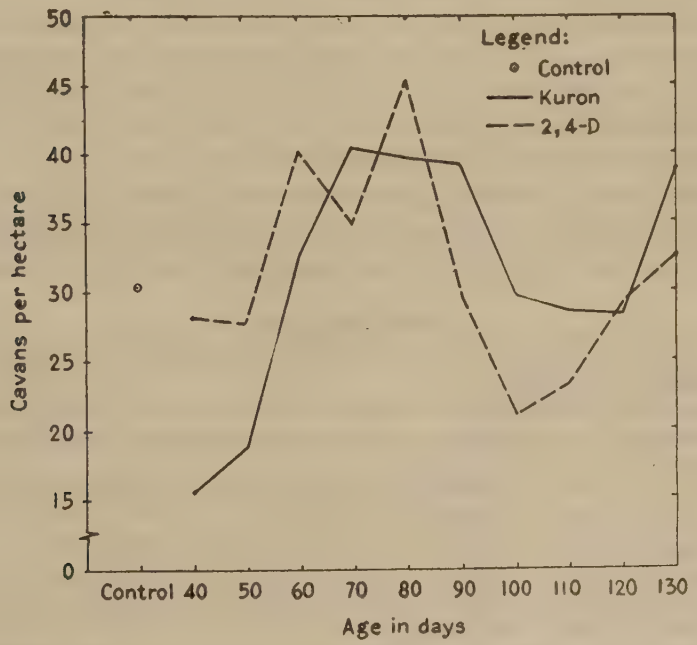

Fig. 2.—Yield of rice plants in cavans per hectare as affected by age of spraying.

Klingman (1947) in his study on wheat, oats, and barley found that treatment made on the boot and heading stages causes greater reduction in yield than application in the seedling stage.

Two weeks after the last spraying in the field experiment (four days before harvesting) and after reducing the moisture content of

the seeds to about fifteen per cent, germination was tested in Petri dishes lined with filter paper kept moist throughout the experiment. This was conducted to determine whether the time of spraying has an effect on the viability of the seeds.

It was found that there was a little 2,4-D in the seeds of plants sprayed at 130 days as shown by the unusual elongation of the coleoptile and non-development of roots. The seeds of plants sprayed with Kuron at the same age did not produce the same rseult; neither did the plants sprayed with 2,4-D at 120 days of age. Although the seedlings were abnormal, the percentage of seeds that germinated, however, was the same as the control.

When another group of seeds was taken from the same batch and germinated in moist soil, it was found that germination was unaffected by both, the herbicide sprayed on the plants and the treatment showing abnormal seedlings in Petri dishes.

It is possible that the 2,4-D was present in the glumes of seeds of plants sprayed at 130 days. When germinated in Petri dishes the herbicide goes into solution and causes the abnormal development of the seedlings. When planted in soil, however, the small amount of herbicide is easily destroyed by soil microorganisms.

Marth *et al.* (1948) did not find any significant difference between the germination percentage of oats, rye, and ryegrass sprayed when the grains were already maturing and those of the unsprayed.

LITERATURE CITED

ARAI, M. and R. KAWASHIMA. 1954. The Journal of Kanto-Tosan Agricultural Experiment Station.

DERSHEID, L. A., L. M. STAHLER and D. E. KRATOCHVIL. 1953. Differential responses of oat varieties to 2,4-Dichlorophenoxyacetic acid (2,4-D), Jour. Amer. Soc. Agron. 45: 11-17.

KAUFMAN, P. B. 1955. Histological responses of the rice plant (Oryza sativa) to 2,4-D. Amer. Jour. Bot. 42: 649-659.

KLINGMAN, D. L. 1947. Effects of spraying cereals with 2,4-D. Jour. Amer. Soc. Agron. 39: 445-447.

LEOPOLD, A. C. 1955. Auxins and plant growth. xv + 354 p. fig. 125. University of California Press.

MARTH, P. C., E. H. TOOLE, and V. K. TOOLE. 1948. Effect of 2,4-Dichlorophenoxyacetic acid in seed development and germination in certain cereal and grass crops. Jour. Amer. Soc. Agron. 40: 916-918.

CONTROL OF TOBACCO INSECTS WITH ORGANIC INSECTICIDES [1]

G. B. Viado, E. C. Punzalan, and A. F. Banaag [2]

WITH FOUR TEXT FIGURES

Heliothis armigera was the most destructive and abundant of six important species of insects found feeding on the tobacco plant. The other important insects were: *Prodenia litura, Phaneroptera furcifera, Plusia chalcytes, Oecanthus indicus,* and *Gnorimoschema heliopa.* Of the seven insecticides tested, DDT gave the highest percentage of sound or undamaged leaves, followed by Endrin, Toxaphene, and Dieldrin. One-week interval of spray application increased considerably the percentage of sound leaves over the two-week schedule. In the weekly schedule, Toxaphene gave the highest increase of sound leaves over the two-week schedule, followed by Dieldrin and DDT. The difference in yield between the control and any of the treatments was insignificant, indicating that the weight of the eaten portions of the leaves was too small to give a significant effect on the total yield. Only BHC showed slight burning effect on young leaves, which disappeared in a few days.

In the laboratory tests, Dieldrin was the most effective of the insecticides tested against *Plusia chalcytes* and *Phaneroptera furcifera.* It was as effective as DDT against *Prodenia litura.* Against *Heliothis armigera,* DDT was best, followed by Dieldrin and Toxaphene. Methoxychlor was the least effective of the insecticides against any of the insects tested.

Meager information is available on the effectiveness of synthetic organic insecticides against insect pests affecting tobacco in the Philippines. Organic insecticides are currently in use for the control of tobacco insects in other countries particularly in the United States. To find out if these insecticides will prove effective in this country inspite of differences in climatic conditions and species of insects involved, this study was conducted from October, 1954, to June, 1956, at the Central Experiment Station, U.P. College of Agriculture, and at the Central Luzon Agricultural College. Muñoz, Nueva Ecija.

---

[1] Central Experiment Station Contribution No. 1919.

[2] The authors acknowledge the help given by Dr. J. G. Matthysse, former Visiting Professor of Entomology, in planning one of the experiments in this project. The cooperation of the authorities at the Central Luzon Agricultural College by providing a planted area for conducting one of the tests presented in this paper is likewise acknowledged.

MATERIALS AND METHODS

The seedlings which were used in the first two tests were sown in the last week of October, 1955, and were set in the field at the age of about 40 days. A third test was conducted at the Central Experiment Station during the 1954-1955 crop season. All agronomic practices in connection with the field culture of tobacco were followed in all these tests. The amounts of insecticides used per 100 gallons of water were as follows:

10% Gamma BHC wettable powder	1½ pounds
50% DDT wettable powder	2 and 4 pounds
25% EPN wettable powder	1½ pounds
50% Methoxychlor wettable powder	2 pounds
40% Toxaphene wettable powder	2½ pounds
60% Toxaphene emulsifiable concentrate	1 pint
19.5% Endrin emulsifiable concentrate	1 pint
15% Dieldrin emulsifiable concentrate	1 pint

In spraying with compressed-air hand sprayers with 2-gallon capacity, emphasis was given to the very susceptible young leaves including the bud and tender portion of the stem.

The species of insects causing damage to the plants and the nature and extent of damage by each species were observed in the tests. The leaves were grouped into four categories, depending upon the extent of damage, namely, (1) sound or undamaged, (2) slightly damaged, when approximately one-fifth or less of the surface was eaten by insects, (3) moderately damaged, when more than one-fifth but not more than two-fifths was devoured, and (4) severely damaged, when more than two-fifths of the entire leaf surface was eaten. The counts were taken on the plants before any leaf was harvested. The harvested leaves were dried under the shade and the yield of dry leaves weighed.

The test conducted at the Central Experiment Station during the 1955-1956 season consisted of five complete randomized blocks, each block with five treatments and a control. Each plot measured 6 by 6 meters. The variety Simmaba was used. Five insecticides were tested, namely, DDT at 2 pounds, Dieldrin, Toxaphene emulsifiable concentrate, BHC, and Methoxychlor. Six spray applications at 10-day intervals starting at about two months from transplanting when about 50 per cent of the plants showed damage by insects were made. Two observations on the extent of damage by insects on the plants

were taken during the test, one on March 9 and the other on April 18, 1956, about one week before the last harvest.

The other test at the Central Experiment Station was conducted during the 1954-1955 season. The same variety of tobacco and insecticides sprayed in the 1955-1956 test at this location except that two schedules, three and six spray applications, were used. The interval of application in the three-spray schedule was two weeks and in the six-spray schedule, one week.

Eight complete randomized blocks, each block consisting of six plots representing six treatments including the control, were used in the test conducted at the Central Luzon Agricultural College. Each plot or replicate measured 12.5 by 7 meters. One row between plots served as guard row. Data were taken from six rows. Virginia tobacco of the variety Golden Harvest was used. Four insecticides, one in two dosages, were tested, namely, DDT at 2 and 4 pounds, Toxaphene wettable powder, Endrin, and EPN. Four sprays at two-week intervals starting on February 1, 1956, were applied. The first spray application was made when the plants were about two months from the time of transplanting. By this time insects were abundant and caused considerable damage to the plants. Before each spray application, a piece of string was tied loosely around the stem just below the terminal bud of 12 plants to a plot or 2 plants picked at random from each of the six rows. The data obtained from the leaves between two adjacent strings were separated.

The effects of different spray materials on apparently full grown but actively feeding larvae of *Heliothis armigera, Prodenia litura,* and *Plusia chalcytes,* and on the nymphs and adults of *Phaneroptera furcifera* were studied in the laboratory. The insects were collected from untreated tobacco plants in the field. Cylindrical screen cages about 12 centimeters in diameter and 22 centimeters tall were used. Two young undamaged tobacco leaves, one sprayed with insecticide and the other untreated were placed side by side in the cage but not touching each other. The petiole of each leaf was immersed in a vial of water to prevent wilting. A DeVilbiss hand atomizer was used in spraying the treated leaf. The larvae were introduced on the treated leaf in each cage. The extent of feeding and the number of dead insects were noted every 24 hours from the start of the test until all the insects in the treated lots died. The repellent action of the insecticides to the insects as shown by the extent of feeding on the treated and untreated leaves was also noted.

RESULTS AND DISCUSSION

Field Tests

Insects that affected the plants. In all the tests, the following insects were observed feeding on the plants in the field: *Heliothis armigera* Hübn., *Prodenia litura* Fabr., *Phaneroptera furcifera* Stal., *Plusia chalcytes* Fabr., *Oecanthus indicus* Sauss., and *Gnorimoschema heliopa* Low. All the species, except *Gnorimoschema heliopa,* which is a stalk borer, are leaf-feeders. The tobacco bud moth, *Heliothis armigera,* was the most numerous and the most destructive of the species affecting the plants in both localities. The caterpillar feeds voraciously on the young leaves and buds. *Phaneroptera furcifera* was also numerous but being a weak feeder it did not cause as much injury as the former species. Only two plants at the Central Experiment Station and five at the Central Luzon Agricultural College were attacked by the borer, *Gnorimoschema heliopa.*

Effects on the percentage of sound or undamaged leaves. The results of the test conducted at the Central Experiment Station during the 1955-1956 season show considerable differences in the percentage of sound leaves in the various treatments. In the first observation all the treatments increased significantly the percentage of sound leaves over the control (table 1a). The best treatment was DDT, followed by Toxaphene, Dieldrin, BHC, and Methoxychlor. The differences between the control and the treatments in the slightly damaged leaves were insignificant but in the moderately and severely damaged leaves they were significant. Almost identical results

TABLE 1a.—*Percentage of sound and damaged leaves at the first observation March, 1956, in the test conducted at the Central Experiment Station, 1955–1956 season*

TREATMENT	SOUND	DAMAGED			
		Slight	Moderate	Severe	Total
DDT, 2 lbs.	67.76	17.80	9.09	5.35	32.24
Dieldrin	62.10	16.32	10.53	11.45	38.30
Toxaphene	62.47	15.37	13.27	8.89	37.53
BHC	57.63	16.90	11.40	14.08	42.38
Methoxychlor	48.23	20.17	13.47	18.14	51.78
Control	40.79	19.90	16.64	22.67	59.21
S.M.D. (T) at 5%	10.53	[a]	3.69	8.11	10.49
S.M.D. (T) at 1%	14.37	[a]	5.04	11.07	14.31

[a] Insignificant.

TABLE 1b.—*Percentage of sound and damaged leaves at the second observation, April 18, 1956, in the test conducted at the Central Experiment Station, 1955–1956 season*

TREATMENT	SOUND	DAMAGED			
		Slight	Moderate	Severe	Total
DDT, 2 lbs.	75.93	15.02	6.60	2.45	24.07
Dieldrin	65.29	19.09	8.11	7.50	34.70
Toxaphene	70.08	17.44	8.08	4.34	29.86
BHC	59.60	20.94	11.06	10.38	42.38
Methoxychlor	49.42	32.08	10.38	8.12	50.58
Control	54.06	25.65	12.62	7.67	45.94
S.M.D. (T) at 5%	10.74	9.05	2.56	4.32	10.64
S.M.D. (T) at 1%	14.65	12.35	3.50	[a]	14.51

[a] Insignificant.

were obtained in the second observation (table 1b), with the same sequence of effectiveness of the various insecticides and almost the same degree of significance of the difference between the control and the treatments in the percentages of sound leaves. The differences between the control and the treatments in the various categories of damaged leaves, however, were significant.

In the 1954-1955 test, the results obtained followed the same pattern as the other test (table 2). The best spray in both schedules of application was DDT, followed closely by Toxaphene and Dieldrin. Methoxychlor and BHC gave poor results.

TABLE 2.—*Efficacy of five insecticides in two schedules of application in the control of tobacco leaf-feeding insects in a test conducted at the Central Experiment Station, 1954–1955 season*

TREATMENT		SOUND LEAVES	AVERAGE WEIGHT OF DRY LEAVES PER PLANT	AVERAGE WEIGHT OF 100 DRY LEAVES	WEIGHT OVER THE CONTROL BASED ON 100 LEAVES
		%	g.	g.	g.
DDT, 2 lbs.	3×	34.3	69.7	494.0	37.2
	6×	73.2	78.8	532.1	75.3
Dieldrin	3×	22.9	70.9	479.6	22.8
	6×	70.9	75.2	519.9	63.1
Toxaphene	3×	16.5	72.9	496.1	39.3
	6×	72.3	79.3	518.7	61.9
BHC	3×	3.5	66.7	460.9	4.1
	6×	10.8	64.5	479.9	23.1
Methoxychlor	3×	9.1	71.2	474.9	16.1
	6×	12.1	69.9	495.6	38.8
Control		4.7	60.4	456.8	

The results of the test conducted at Muñoz show that DDT at 4-pound level gave the highest percentage of sound leaves, followed by Endrin, Toxaphene, and DDT at 2-pound level (table 3). EPN, which gave the lowest percentage of sound leaves, was only 12.75 per cent over the control. The difference between the control and any of the treatments, however, was significant. The differences between the control and the treated in the slightly and severely damaged leaves were, likewise, significant. No significance was noted in the moderately damaged leaves.

TABLE 3a.—*Percentage of sound and damaged leaves in the various treatments in the test at Muñoz, Nueva Ecija, based on the total number of leaves covered by three successive sprays at two-week intervals*

TREATMENT	SOUND	DAMAGED			
		Slight	Moderate	Severe	Total
DDT, 2 lbs.	31.50	28.94	17.03	22.54	68.50
DDT, 4 lbs.	42.33	23.26	15.59	18.82	57.67
Endrin	39.37	24.71	13.94	21.98	60.63
EPN	23.19	20.98	18.39	37.44	76.81
Toxaphene	36.68	24.02	15.54	23.76	63.32
Control	10.44	9.43	18.62	61.51	89.56
S.M.D. (T) at 5%	10.33	9.34	[a]	16.04	11.98
S.M.D. (T) at 1%	13.87	12.53	[a]	21.52	16.07

[a] Insignificant.

In all the tests conducted, DDT was best. Several investigators reported on the effectiveness of DDT against several insect pests of tobacco. In New South Wales, Morgan (1949) reported that a spray containing 0.05 per cent DDT controlled insect pests of tobacco, such as cutworm, looper (*Plusia* sp.), budworm (*Heliothis armigera*), leaf miner and stem borer. For the control of *Heliothis armigera*, Smith (1954) found that a spray containing 0.1 per cent DDT in the form of emulsion was best. In an earlier paper, this same author (Smith, 1953) recommended the use of 0.1 per cent DDT spray in the seedbed and as weekly spray for the first three weeks in the field. In the presence of the tobacco looper, the use of 0.05 per cent Dieldrin was suggested. Fox *et al.* (1949) reported the superiority of DDT over several insecticides including BHC, Calcium arsenate, and Lead arsenate, for the control of the tomato hornworm on tobacco in Ontario. Control of various insect pests of tobacco with DDT dust was reported by Allen (1946), Dominick (1950), and Turner (1950).

The results obtained show that Endrin, Toxaphene, and Dieldrin compared favorably with DDT in effectiveness against the various insects affecting tobacco leaves. In the test at Muñoz, Endrin and Toxaphene were more effective than DDT at the 2-pound level. Allen *et al.* (1953) found Toxaphene very effective and Endrin a promising insecticide against the tobacco hornworm larvae. Kuitert and Tissot (1949) reported that Toxaphene was among the four most effective of the 15 insecticides they tested against the tobacco budworm and the hornworm. In his work on the control of hornworms on tobacco, Dominick (1950, 1951) found that these insects were controlled effectively with Toxaphene and that one per cent Dieldrin dust killed about 86 per cent of the larvae. Smith (1954) recommended 0.05 per cent Endrin or Dieldrin spray for the control of the lopper, leafminer, and *Prodenia litura* on tobacco. Kring (1955) reported that 0.5 pound actual Endrin in 100 gallons spray per acre gave only 52 per cent reduction of cutworm damage on tobacco. For the control of hornworms and grasshoppers on tobacco, Turner (1950) stated that one application of 10 per cent Toxaphene dust at 10 to 20 pounds per acre was usually sufficient.

Effects of spraying interval on the percentage of sound leaves. The two tests conducted at the Central Experiment Station and at Muñoz, during the 1955-1956 season were sprayed at two-week intervals (tables 1a and 1b). The average of two observations showed that with this interval, DDT gave 71.85 per cent sound or undamaged leaves, Dieldrin, 63.70 per cent; Toxaphene, 66.28; BHC, 58.62; Methoxychlor, 48.83; and control, 47.43. In the other test conducted at the Central Experiment Station, the weekly interval of application gave an increase of sound leaves over the two-week interval, 38.9 per cent for DDT, 48.0 per cent for Dieldrin, 55.8 for Toxaphene, 7.3 for BHC, and 3.6 for Methoxychlor (table 2 and figures 1 to 4). Toxaphene gave the highest increase of sound leaves followed by Dieldrin and DDT. BHC and Methoxychlor did not give appreciable increase by shortening the interval of spraying from two weeks to one week. The six-spray schedule with weekly intervals gave more than 100 per cent increase of sound leaves over the two-week interval or three-spray schedule with DDT, over 300 per cent with Dieldrin, and over 400 per cent with Toxaphene. In the present study the two-week interval did not give satisfactory control of insect pests damaging the leaves. In New South Wales, Morgan (1949) reported that three applications at two-week intervals with 0.1 per cent DDT spray or 2 per cent DDT dust starting two weeks

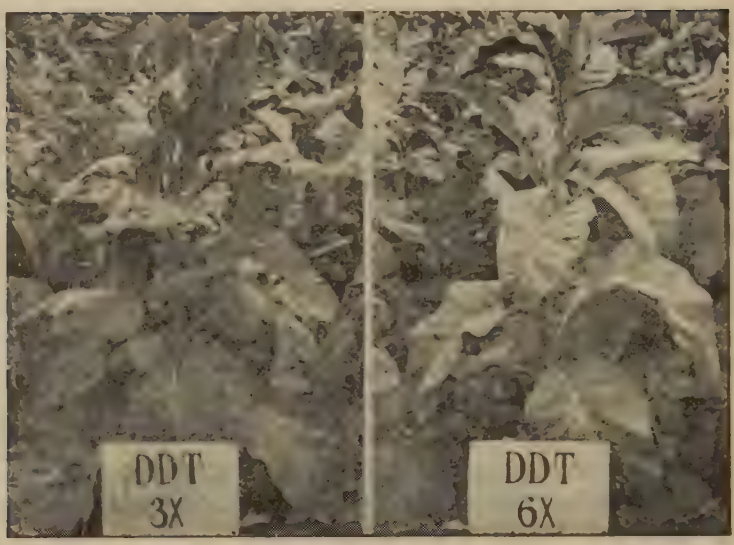

Fig. 1.—Representative plants from lots sprayed with DDT. The plant on the left panel received three two-week interval sprayings while the plant at the right panel received six one-week interval sprayings. Note difference in damage between the two plants.

Fig. 2.—Representative plants from lots sprayed with Dieldrin. The plant on the left panel received three two-week interval sprayings while the plant at the right panel received six one-week interval sprayings. Note difference in damage between the two plants.

Fig. 3.—Representative plants from lots sprayed with Toxaphene. The plant on the left panel received three two-week interval sprayings while the plant at the right panel received six one-week interval sprayings. Note difference in damage between the two plants.

Fig. 4.—A representative plant from control lots showing severe damage caused by insects

from transplanting was effective against tobacco insects such as cutworm, looper, budworm, leaf miner, and stem borer.

The number of leaves which received the various sprays in the test at Muñoz are shown in table 3b. The leaves were marked by tying loosely a piece of string around the stem just below the terminal bud before each spray application. The average number of leaves produced by a plant in two weeks ranged from 5 to 10. The average total number of leaves to a plant which received four spray applications at two-week intervals ranged from about 35 to 42. It is apparent from the result that in two weeks an average of about seven leaves were produced by the plant, all of which were not sprayed and so were exposed to insect attack during the two-week period.

TABLE 3b.—*Average number of leaves to a plant sprayed in the test at Muñoz, Nueva Ecija*

TREATMENT	DATE OF SPRAY APPLICATION 1955				TOTAL
	February 1[a]	February 15	February 29	March 15	
DDT, 2 lbs.	18.0	6.9	6.9	7.6	39.4
DDT, 4 lbs.	16.6	8.3	9.9	6.6	41.4
Endrin	16.8	6.4	8.5	5.3	37.0
EPN	17.0	7.4	6.4	6.0	36.8
Toxaphene	15.9	7.5	8.9	5.5	37.8
Control	16.3	7.1	5.8	5.2	34.4
Total	100.6	43.6	46.4	36.2	
Mean	16.8	7.3	7.7	6.0	

[a] Most of the leaves which received this spray were "sand" leaves.

Yield. In the test at the Central Experiment Station during the 1955-1956 season, the mean yield of dry leaves in kilograms of the various treatments were: 2.78 for DDT, 2.66 for Dieldrin, 2.70 for Toxaphene, 2.67 for BHC, 2.49 for Methoxychlor, and 2.08 for the control. The difference between the control and any of the treatments, however, was not significant. In the 1954-1955 season test the difference in yield between the three-spray schedule and the six-spray schedule for all the treatments was likewise insignificant. The mean yield of dry leaves in kilograms in the test at Muñoz were: 2.36 for DDT 2 pounds , 2.12 for DDT 4 pounds, 1.92 for Endrin, 1.64 for EPN, 2.46 for Toxaphene, and 1.89 for the control. The difference between the control and any of the treatments, however, was insignificant. The insignificant difference in the mean weight

of dry leaves between the control and any of the treatments in all the tests showed that the weight of the eaten portion of the leaves was too small to give a significant effect on the total weight of the yield. It was noted that most of the eaten portions of the leaves were on the thin lamina, excluding the large veins of the leaves.

Herbicidal effect of the organic insecticides. Of the seven insecticides tested only BHC showed slight burning effect on the leaves, which eventually disappeared after a few days. Ashby (1950) reported that DDT applied as spray at the rate of 27 pounds in suspension per acre to seedbeds before sowing or 75.6 pounds of the dust per acre to three-week old seedlings had no herbicidal effects. He also found that Toxaphene applied as pre-sowing spray at the rate of 6.4 pounds per acre of the 25 pounds per acre, however, caused temporary distortion and stunting on 11-day old seedlings, but 75.6 pounds per acre showed considerable mortality on three-week old seedlings. Ashby further stated that resistance to herbicidal effects of BHC increased with age of the plants.

Laboratory Tests

The effects of five insecticides on four species of insects affecting the tobacco plant when applied on the leaves as contact and stomach poisons were studied in the laboratory. On *Heliothis armigera* DDT was best, killing 50 per cent of the larvae in 24 hours and all the larvae in 96 hours (table 4a). DDT showed some repellent action as indicated by the slight feeding of the larvae on the treated leaves. Dieldrin was next best, killing 43 per cent of the larvae in 24 hours and all the larvae in 120 hours. This insecticide also showed some repellent action on the larvae. Toxaphene was third best, killing 23 per cent of the larvae in 24 hours and all the larvae in 120 hours. No repellent action was shown by this insecticide on the larvae. BHC and Methoxychlor were the poorest of the insecticides tested, killing the larvae in 168 hours. BHC showed some repellent action on the larvae while Methoxychlor did not.

The test on *Prodenia litura* (table 4b) showed that DDT was the most effective, killing 20 per cent of the larvae in 24 hours and all the larvae in 96 hours. The insecticide apparently had no repellent action on the larvae. Dieldrin was as toxic as DDT to this species, but showed some repellent action on the larvae. Toxaphene killed about 17 per cent of the larvae in 24 hours and all the larvae in 120 hours and had no repellent action. BHC also killed all the lar-

TABLE 4a.—*Effects of five insecticidal sprays on 30 larvae of Heliothis armigera in each treatment*

TREATMENT	LARVAE KILLED AFTER SPECIFIED NUMBER OF HOURS							REMARKS
	24	48	72	96	120	144	168	
DDT, 2 lbs.	15	25	29	30				Larvae fed slightly on the treated leaves but heavily on the untreated leaves.
Dieldrin	13	25	25	29	30			Larvae fed heavily on the untreated leaves but slightly on the treated leaves.
Toxaphene	7	15	19	26	30			Larvae fed equally on the treated and untreated leaves.
BHC	1	2	7	12	16	26	30	Larvae fed slightly on the treated leaves but heavily on the untreated leaves.
Methoxychlor	0	2	13	16	20	27	30	Larvae fed equally on the treated and untreated leaves.
Control	0	0	0	0	0	0	0	Larvae fed heavily on the leaves.

TABLE 4b.—*Effects of five insecticidal sprays on 30 larvae of Prodenia litura in each treatment*

TREATMENT	LARVAE KILLED AFTER SPECIFIED NUMBER OF HOURS						REMARKS
	24	48	72	96	120	144	
DDT, 2 lbs.	6	19	24	30			Larvae fed equally on the treated and untreated leaves.
Dieldrin	5	18	23	30			Larvae fed heavily on untreated leaves but slightly on treated leaves.
Toxaphene	5	14	19	28	30		Larvae fed equally on the treated and untreated leaves.
BHC	2	14	16	26	30		Larvae fed heavily on untreated leaves but slightly on treated leaves.
Methoxychlor	0	3	7	13	25	30	Larvae fed equally on the treated and untreated leaves.
Control	0	0	0	0	0	0	Larvae fed heavily on the leaves.

vae in 120 hours but killed only 6 per cent of the larvae in 24 hours. It exhibited some repellent action. Methoxychlor killed all the larvae in 144 hours and had no repellent action.

Dieldrin killed about 47 per cent of the larvae of *Plusia chalcytes* in 24 hours and all the larvae in 72 hours but exhibited some repellent action (table 4c). DDT was next best, killing 33 per cent of the larvae in 24 hours and all the larvae in 96 hours. It had no repellent action. Toxaphene was slightly less toxic than DDT but killed all the larvae in the same length of time. It had, likewise, no repellent action. BHC was more toxic to this species than Methoxychlor, killing all the larvae in 120 hours as compared with 144 hours with Methoxychlor.

The most toxic of the five insecticides to *Phaneroptera furcifera* was Dieldrin, killing about 50 per cent of nymphs and adults in 12 hours and all of them in 48 hours (table 4d). This insecticide, however, showed repellent action on the insects. Toxaphene, next best, killed 20 per cent of both nymphs and adults in 12 hours, all the adults in 48 hours and all the nymphs in 72 hours. No repellent action of this insecticide was noted. BHC was more toxic than DDT, killing 60 per cent of the adults in 12 hours and all of them in 72 hours. The nymphs were more resistant to this insecticide than the adults. Only 20 per cent were killed in 12 hours and all of them in 96 hours. This insecticide, however, showed some repellent action on the insects. DDT and Methoxychlor did not kill any adult in 24 hours or nymph in 12 hours. DDT, however, killed all the adults in 120 hours and all the nymphs in 96 hours, while Methoxychlor killed all the adults in 168 hours and all the nymphs in 144 hours. Both insecticides had no repellent action on the insects.

In laboratory studies on the toxicity of 13 insecticides to the tobacco hornworm, Guthrie (1954) found Endrin best and DDT least effective, when used both as contact and stomach poisons. Parathion was next best, followed by Isodrin and Lindane. As contact poison, Toxaphene was as effective as Dieldrin, Aldrin and Malathion. Toxaphene was more effective than Malathion when used as stomach poison.

TABLE 4c.—*Effects of five insecticidal sprays on 15 larvae of Plusia chalcytes in each treatment*

TREATMENT	LARVAE KILLED AFTER SPECIFIED NUMBER OF HOURS						REMARKS
	24	48	72	96	120	144	
DDT, 2 lbs.	5	10	13	15			Larvae fed equally on the treated and untreated leaves.
Dieldrin	7	10	15				Larvae fed heavily on untreated leaves but slightly on treated leaves.
Toxaphene	3	7	11	15			Larvae fed equally on the treated and untreated leaves.
BHC	0	4	8	11	15		Larvae fed heavily on untreated leaves but slightly on treated leaves.
Methoxychlor	0	2	7	9	14	15	Larvae fed equally on the treated and untreated leaves.
Control	0	0	0	0	0	0	Larvae fed heavily on the leaves.

TABLE 4d.—*Effects of five insecticidal sprays on 15 adults and 15 nymphs of Phaneroptera furcifera in each treatment*

TREATMENT		ADULTS AND NYMPHS KILLED AFTER SPECIFIED NUMBER OF HOURS								REMARKS
		12	24	48	72	96	120	144	168	
DDT, 2 lbs.	adults	0	0	6	10	14	15			Adults and nymphs fed equally on the treated and untreated leaves.
	nymphs	0	1	8	11	15				
Dieldrin	adults	7	14	15						Adults and nymphs fed heavily on the untreated leaves but slightly on the treated leaves.
	nymphs	6	13	15						
Toxaphene	adults	3	9	15						Adults and nymphs fed equally on the treated and untreated leaves.
	nymphs	3	9	13	15					
BHC	adults	9	12	14	15					Adults and nymphs fed heavily on the untreated but slightly on the treated leaves.
	nymphs	3	9	13	14	15				
Methoxychlor	adults	0	0	4	8	11	13	14	15	Adults and nymphs fed equally on the treated and untreated leaves.
	nymphs	0	1	5	9	14	14	15		
Control	adults	0	0	0	0	0	0	0	0	Adults and nymphs fed heavily on the leaves.
	nymphs	0	0	0	0	0	0	0	0	

LITERATURE CITED

ALLEN, NORMAN. 1946. Experiments with DDT for tobacco insect control. Fifty-eighth Report South Carolina Experiment Station. 1944-1945: 108-113.

———— *et al.* 1953. Tobacco hornworm control with organic insecticides. Jour. Econ. Entom. **46**: 604-608.

ASHBY, D. G. 1950. The phytotoxic effects of DDT, BHC, parathion and toxaphene on tobacco. Ann. Applied Biol. **37**: 624-639.

DOMINICK, C. B. 1950. Control of hornworms on tobacco. Jour. Econ. Entom. **43**: 221-222.

————. 1951. Tests with insecticides for hornworm control on tobacco. Jour. Econ. Entom. **44**: 539-541.

FOX, C. J. *et al.* 1949. The chemical control of the tomato hornworm on tobacco in Ontario. Sci. Agric. [Ottawa] **29**: 553-562.

GUTHRIE, F. E. 1954. Laboratory studies on the toxicity of thirteen insecticides to the tobacco hornworm. Jour. Econ. Entom. **47**: 215-218.

KRING, JAMES B. 1955. Control of some tobacco pests. Connecticut (New Haven) Agric. Expt. Sta. Cir. 191. 15 pp.

KUITERT, L. C. and A. N. TISSOT. 1949. Control of budworms and hornworms in flue-cured tobacco. Florida Entom. **32**: 171-177.

MORGAN, W. L. 1949. Insect pests of tobacco; New insecticides tested. Agric. Gaz. N. S. Wales **60**: 536-538; 556.

SMITH, W. A. 1953. Tobacco pest control schedule for the 1953-1954 season. Queensland Agric. Jour. **77**: 91-92.

————. 1954. Tobacco pest control schedule for the 1954-1955 season. Queensland Agric. Jour. **79**: 71-73.

TURNER, NEELY. 1950. Control of tobacco insects. Connecticut (New Haven) Agric. Expt. Sta. Cir. 179. 6 pp.

GROWTH IN WEIGHT OF BERKJALA AND BERKSHIRE SUCKLING PIGS [1]

VALENTE VILLEGAS [2]

The mean birthweights of male and female Berkjala and Berkshire suckling pigs were 0.9 kilogram and 1.1 kilograms, respectively. There was no significant difference between the birthweights of either sex.

The object of this work was to determine the progressive growth in weight of Berkjala and Berkshire pigs from birth up to 56 days of age.

Twenty-nine male and 21 female pigs of the Berkjala breed and 9 male and 6 female Berkshire pigs were weighed daily in the Department of Animal Husbandry from September 19, 1954 to March 14, 1955.

DISCUSSION OF RESULTS

Berkjala. The birthweights and daily weights of male and female pigs throughout the nursing period were statistically the same. The mean birthweight of both sexes was 0.9 kilogram, the confidence intervals being 0.79 and 1.01 kilograms. The birthweight doubled at 9 days of age and the confidence intervals rose to 1.72 and 2.08 kilograms. At 19 and 20 days of age, the birthweight trebled. The confidence intervals then were 2.47 and 2.93 kilograms at 19 days of age and 2.46 and 2.94 kilograms at 20 days of age. As the birthweight quadrupled at 34 and 35 days of age, the confidence intervals became 3.22 and 3.98 kilograms at 34 days of age and 3.21 and 8.99 kilograms at 35 days of age. At 45 days of age, the birthweight quintupled and the confidence intervals increased to 4.01 and 4.99 kilograms. At the end of the nursing period (56 days old), the mean weight was 5.6 kilograms or 6.2 times the birthweight. The confidence intervals were 4.95 and 6.25 kilograms.

Berkshire. The birthweights and daily weights of male and female Berkshire pigs were not significantly different from each other throughout the suckling period. The average birthweight of

[1] Central Experiment Station Contribution No. 1920.

[2] The author is grateful to Messrs. Jacinto L. Gallardo and Rodolfo B. Puyaoan for assistance in carrying out this work.

both male and female Berkshire pigs was 1.1 kilograms. In ten days, the birthweight was slightly more than doubled, the confidence intervals being 1.99 and 2.61 kilograms. At 22 to 25 days of age it trebled. The confidence intervals at 22 days of age were 2.68 and 3.92 kilograms and at 25 days of age, 2.80 and 3.80 kilograms. At 35 days old, the birthweight was a little more than four times, while the confidence intervals were 3.89 and 5.31 kilograms. The birthweight quintupled at 49 days of age and the confidence intervals became 4.77 and 6.23 kilograms. At the end of the nursing period (56 days of age), the mean weight was 6.3 kilograms, or 5.7 times the birthweight, the confidence intervals being 5.47 and 7.13 kilograms.

The following data give us the combined mean weights of male and female Berkjala and Berkshire suckling pigs:

AGE IN DAYS	MEAN WEIGHT OF BERKJALA	MEAN WEIGHT OF BERKSHIRE	AGE IN DAYS	MEAN WEIGHT OF BERKJALA	MEAN WEIGHT OF BERKSHIRE
	kgm.	*kgm.*		*kgm.*	*kgm.*
1	0.9	1.1	29	3.3	4.0
2	1.0	1.1	30	3.4	4.0
3	1.1	1.2	31	3.4	4.1
4	1.2	1.3	32	3.5	4.2
5	1.3	1.5	34	3.6	4.3
6	1.4	1.5	34	3.6	4.3
7	1.6	1.8	35	3.6	4.6
8	1.7	2.0	36	3.7	4.5
9	1.8	2.1	37	3.8	4.6
10	1.9	2.3	38	3.8	4.7
11	2.0	2.4	39	3.9	4.7
12	2.1	2.4	40	4.0	4.8
13	2.2	2.5	41	4.1	4.8
14	2.3	2.6	42	4.2	4.9
15	2.4	2.7	43	4.3	5.0
16	2.4	2.8	44	4.4	5.1
17	2.5	2.9	45	4.5	5.2
18	2.6	3.0	46	4.6	5.3
19	2.7	3.2	47	4.7	5.4
20	2.7	3.2	48	4.8	5.8
21	2.8	3.2	49	4.8	5.5
22	2.9	3.3	50	4.9	5.7
23	2.9	3.3	51	5.0	5.7
24	3.0	3.3	52	5.1	5.8
25	3.1	3.3	53	5.3	5.9
26	3.1	3.5	54	5.4	6.0
27	3.2	3.3	55	5.5	6.1
28	3.2	3.8	56	5.6	6.3

MAJOR PHILIPPINE AGRICULTURAL EXPORTS IN 1954[1]

EDEN M. VARONA

The principal exports of the Philippines in 1954 were coconut, sugar cane, abaca, and tobacco. Copra, the leading product, made up 45 per cent of the total exports; centrifugal sugar, the next, 31 per cent.

The United States was the largest buyer of the principal exports. The Netherlands, Japan, Denmark, Colombia and Germany were good buyers of copra, Manila hemp, and leaf tobacco.

Among the busiest ports were Manila, Cebu, Negros Occidental, Iloilo, and Quezon. A large amount of coconut products was shipped from Manila, Cebu, and Quezon. Negros Occidental, Manila, and Iloilo handled most of the sugar exports. Manila hemp was shipped from Manila, Cebu, and Davao in large volumes. Tobacco was mainly handled in Manila.

The foreign trade of the Philippines, particularly in agricultural products, constitutes the major source of income for the country most of which goes to the farmer. To maintain a progressive export trade of agricultural products problems of production, marketing, and changes in the world situation should be taken into account.

After the last war, changes in world conditions necessitated adjustment of the then current procedure of exporting products. This was accomplished on May 11, 1951 by Republic Act No. 613 which created the Export Control Committee. This body takes charge of processing applications for the exportation or re-exportation of commodities.

Before the last war, the principal export crops of the Philippines were sugar cane, coconut, abaca, and tobacco. Since these crops are still our leading exports information on the methods of exporting them would help the government in its program of economic rehabilitation.

THE STUDY

The object of this study conducted in the summer of 1955 was to determine the kind, value, port of origin, and destination of the principal agricultural exports of the Philippines in 1954.

[1] Central Experiment Station Contribution No. 1921. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1956. Prepared in the Department of Agricultural Economics under the direction of former Visiting Professor Chase DelMar Kearl.

Data were obtained from the approved applications on file at the office of the Export Control Committee in Manila.

In collecting the data, each month was considered as a stratum and four samples, each representing one day, were drawn at random from each stratum. Out of 48 samples, 315 applications representing 18 per cent of all kinds of applications approved during the year were obtained.

The data gathered were processed in the Department of Agricultural Economics, College of Agriculture, and Central Experiment Station, College, Laguna.

THE AGRICULTURAL EXPORTS

Principal exports. Coconut, sugar cane, abaca, and tobacco were the principal export crops of the Philippines in 1954 (table 1). Copra was the most important and made up 45 per cent of all exports; centrifugal sugar was next with 31 per cent. Manila hemp exports were 11 per cent of the total; desiccated coconut, 5 per cent; coconut oil, 4 per cent; copra cake, 2 per cent; and leaf tobacco, 2 per cent.

Months of shipment. The monthly shipment of exports was lowest in August and highest in April (table 2). The shipment of coconut products was lowest in May and highest in October. A large quantity of sugar was exported during the months of April and May and to a somewhat lesser extent in March and June. These months are during the heavy milling season. Fibers were exported in large quantities during the months of January, February, April, and May. The biggest tobacco shipments were made during the months of February, March, and August.

Principal buyers of Philippine exports. The United States was the largest buyer of Philippine exports (table 3). Several countries in Europe as well as Japan, Colombia and Venezuela likewise were good buyers. The economic relations which have been existing between the United States and the Philippines for the last half century resulted in the voluminous trade between the two countries.

Ports of export. About 77 per cent of the volume of agricultural exports of the Philippines in 1954 was handled in the ports of Manila, Cebu City, Negros Occidental, Iloilo City and Quezon (table 4). Legaspi, Zamboanga, Davao, Negros Oriental and Cagayan de

Oro shipped the rest of the products. The concentration of export shipments at the first five ports may be attributed to the presence of large buyers, shipping companies, port facilities, transportation system, good roads, convenient location, financial institutions, well-developed business and availability of labor.

TABLE 1.—*Agricultural exports of the Philippines in 1954*

EXPORTS		VALUE IN PESOS	PERCENTAGE
Coconut products:			
Copra		267,833,464	45
Desiccated coconut		27,707,417	5
Coconut oil		25,657,538	4
Copra cake		9,579,749	2
Copra meal		1,727,725	[a]
Copra oil meal		227,715	[a]
Coconut syrup		26,374	[a]
	Total	332,759,982	56
Sugar and related products:			
Centrifugal sugar		182,617,739	31
Molasses		2,030,983	[a]
Refined sugar		1,724,979	[a]
	Total	186,373,701	31
Fibers and manufactures:			
Manila hemp		66,432,229	11
Mats, rugs and slippers		1,205,290	[a]
Manila rope		1,073,264	[a]
Ramie		74,353	[a]
	Total	68,785,136	11
Tobacco and by-products:			
Leaf tobacco		8,561,064	2
Scrap and cut tobacco		1,871,713	[a]
Cigars and cigarettes		459,963	[a]
	Total	10,892,740	2
	Total	598,811,559	100

[a] Less than 1 per cent.

TABLE 2.—*Monthly agricultural exports of the Philippines in 1954*

MONTH	COCONUT PRODUCTS	SUGAR AND PRODUCTS	FIBERS AND MANUFACTURES	TOBACCO	TOTAL
January	23,823,695	10,423,314	13,417,404	——	47,664,413
February	21,229,926	7,140,048	8,668,649	5,244,839	42,283,462
March	25,104,175	21,138,331	3,399,595	1,844,594	51,486,695
April	33,499,115	34,894,771	8,335,696	524,261	77,253,843
May	16,266,770	36,931,714	8,446,932	499,236	62,144,642
June	19,787,025	15,526,664	3,309,058	197,475	38,820,222
July	35,952,222	9,772,117	4,391,323	17,278	50,133,540
August	23,628,952	4,658,680	1,328,514	2,345,372	31,961,518
September	36,100,222	—	1,271,393	21,627	37,393,247
October	51,475,139	10,651,630	6,819,152	55,384	69,001,305
November	26,800,418	23,776,144	6,087,099	97,705	56,761,366
December	19,091,723	11,460,288	3,310,326	44,969	33,907,306
Total	332,799,982	186,373,701	68,785,136	10,892,740	998,811,559

TABLE 3.—*Destination of agricultural exports in 1954*

COUNTRY	VALUE IN PESOS	PERCENTAGE
United States	369,568,652	61
Netherlands	47,397,328	8
Japan	28,691,435	5
Denmark	27,459,250	5
Colombia	13,166,894	2
Germany	10,484,029	2
Venezuela	9,352,109	2
Great Britain	9,170,211	2
Italy	7,460,084	1
Spain	7,157,135	1
Other countries	68,904,432	11
Total	598,811,559	100

Products shipped from principal ports. A large volume of coconut products was handled at the ports of Cebu and Manila. The port of Quezon was third. Desiccated coconut was principally shipped at the port of Manila because two big factories were just a few miles away. Most of the coconut oil exported was also shipped from Manila.

TABLE 4.—*Principal ports of shipment of agricultural exports of the Philippines in 1954*

PORT	VALUE IN PESOS	PERCENTAGE
Manila	177,322,004	30
Cebu City	108,592,004	18
Negros Occidental	77,990,730	13
Iloilo City	47,771,664	8
Quezon	46,022,770	8
Legaspi	17,687,221	3
Zamboanga	15,389,913	2
Davao	13,328,298	2
Negros Oriental	13,013,616	1
Cagayan de Oro	11,345,000	1
Other ports	70,348,339	13
Total	598,811,559	100

Sugar products were shipped in large volumes from the ports of Negros Occidental, Manila, and Iloilo. The bulk of sugar export in the Visayas came from Negros Occidental and Iloilo; the sugar from Central Luzon, Laguna, and Batangas was shipped from Manila.

The principal shipping ports of Manila hemp were Manila, Cebu and Davao. The bulk of the shipments was made in Manila. Tobacco exports were mainly handled at the port of Manila because the large producers of tobacco are in Luzon.

Monthly export shipment. Manila, Cebu City, and Legaspi handled export shipments throughout the year. The port of Quezon was busy for 11 months; Iloilo City, 10 months; Negros Occidental, 9 months; Zamboanga and Davao, 8 months each; Negros Oriental, 7 months; Cagayan de Oro, 3 months. The volume of export shipments was generally high when the port was busy throughout the year. Although Legaspi handled shipments throughout the year, it shipped comparatively very much less volume than the other large ports.

Ships that carried the agricultural exports. About 70 per cent of the ships calling in the Philippine ports each handled less than two million pesos worth of shipping during the year. The bulk of the year's shipments, however, was handled by eleven ships each of which handled exports valued at eight million pesos or more. They were: MV *Kyoyu Maru,* SS *Mason Lykes,* MS *Suez Maru,* MS *Califoria Bear,* SS *Norlandia,* MV *Laura Maersk,* SS *Eugene Lykes,* SS *Hopeville,* SS *Myrmidon,* MS *Reinhalt,* and SS *Venus.*

THE EFFECT OF AUROFAC UPON THE RATE OF GROWTH OF GROWING-FATTENING PIGS

Aurofac which contains vitamin B_{12} and aureomycin was added to the College growing-fattening ration to determine if it would enhance the feeding value of the latter.

Eight barrows and six female Berkshire weanling pigs of approximately the same size, weight and age were allotted at random in two lots of seven pigs each, with sexes equally distributed in the two lots. Lot I pigs (control) were hand-fed twice daily with the College standard swine rations while lot II pigs (experimental) were given these same rations supplemented by one-half kilogram Aurofac to every 100 kilograms of the mash. The feeding trial was equally divided into three feeding periods. Both lots were given identical care and management. The initial and weekly weights of the pigs were recorded. The amount of feed consumed during each feeding period and other minor observations were also taken.

Gain in weight and feed consumption of the lots after the 30-week feeding trial were:

	LOT I	LOT II
Average gain in weight of pigs, kgm.	51.75	58.75
Average feed consumption, kgm.	207.98	215.15
Feed consumed per kg. gain, kgm.	4.02	3.67

The Aurofac supplement did not significantly improve the rate of growth of growing-fattening pigs although Aurofac-fed pigs had glossier and smoother skin, and exhibited finer hair than the control.

The average amount of feed needed to produce a kilogram gain during the entire 30-week feeding period was 4.03 kilograms in lot I and 3.70 kilograms in lot II. Considering the cost of Aurofac in lot II the respective costs were ₱0.80 and ₱0.83.

—F. S. MENSALVAS and Q. M. SUGON

SUITABILITY AND FERTILIZING VALUES OF HORSE BEDDINGS

Nine types of horse beddings were studied as to period of usefulness, increase in weight, and amount and value of fertilizing ingredients at the time of collection. The usefulness of the beddings ranged from 8.2 + 1.240 days for batadbatadan to 20.0 + 4.919 days for corn husks and 20.0 ± 3.346 days for sawdust. The weight of used beddings collected varied from 19.1 to 59.6 kilograms.

The amount and value of nitrogen, phosphorus and potassium contained in the different beddings at the time of collection follow:

USED BEDDINGS	NITROGEN		PHOSPHORUS		POTASSIUM	
	kgm.	pesos [a]	kgm.	pesos [a]	kgm.	pesos [a]
Sawdust	.22	.24	.02	.06	.01	.01
Wood shavings	.11	.12	.01	.04	.01	.01
Ground corn cob	.26	.28	.01	.04	.08	.06
Corn husks	.13	.14	.01	.04	.03	.02
Rice straw	.11	.12	.002	.01	.01	.01
Cogon	.08	.09	.01	.04	.01	.01
Batadbatadan	.12	.13	.02	.06	.04	.03
Balangot	.10	.11	.02	.06	.03	.02
Acacia leaves	.51	.55	.31	1.02	.08	.06

[a] Prices based on N at ₱1.08, P_2O_5 at ₱0.71, and K_2O at ₱0.29 a kilogram.

—V. VILLEGAS, J. C. MADAMBA and L. L. AUSTRIA

THE COMPARATIVE VALUES OF THE CARCASS OF RAMS AND WETHERS

To a butcher knowledge of the dressing percentage of his animal is important in anticipating profit or loss. This work was undertaken to obtain local data on the dressing percentage of sheep. Five rams and five wethers of about two years of age were slaughtered and the following data were obtained from them:

	RAMS	WETHERS
Live weight, kg.	35.1 ± 2.65	30.1 ± 1.53
Dressed weight, kg.	18.89 ± 1.56	15.69 ± 0.61
Dressing percentage	53.71	52.18
Lean, kg.	13.8 ± 1.3	12.0 ± 0.6
Bones, kg.	5.09 ± 0.51	3.6 ± 0.2
Shorn pelt, kg.	2.65 ± 0.12	1.92 ± 0.11
Visceral fat, kg.	1.83 ± 0.34	3.17 ± 0.37
Shed blood, kg.	1.16 ± 0.28	1.19 ± 0.03
Tongue, g.	109.0 ± 16.2	102.0 ± 11.9
Brain, g.	86.8 ± 5.4	84.2 ± 3.8
Heart, g.	127 ± 8.7	105 ± 4.1
Lungs, g.	227 ± 41.5	199 ± 9.0
Liver, g.	462 ± 41.6	367 ± 12.8
Spleen, g.	37.0 ± 6.2	40.0 ± 3.2
Kidney, g.	68.2 ± 7.3	58.0 ± 3.9
Rumen	789.4 ± 138.3	461.0 ± 7.9
Reticulum	76.7 ± 14.5	
Omasum, g.	73.3 ± 6.7	130.0 ± 10.9
Abomasum, g.	190.0 ± 25.2	168.5 ± 17.7
Testicle, g.	283 ± 0.01	—
Length of trachea	25.3 ± 1.3	27.1 ± 0.6
Length of esophagus	40.8 ± 1.0	42.2 ± 2.0

The lean gave the following analysis:

	RAMS	WETHERS
Per cent moisture	64.8 ± 0.5	57.3 ± 1.8
Per cent crude protein	17.4 ± 1.4	15.1 ± 1.2
Per cent crude fat	16.6 ± 1.3	25.4 ± 1.2
Per cent ash	1.2 ± 0.1	0.83 ± 0.02
Per cent CaO	—	0.04 ± 0.02
Per cent P_2O_5	—	0.32 ± 0.01
Calorific value per 100 grams	219.5 ± 6.5	301.4 ± 12.8

—VALENTE VILLEGAS

A COMPARISON OF THE "FILTER PAPER" AND A.O.A.C. METHODS OF MOISTURE DETERMINATION IN MOLASSES

Moisture determination in molasses is locally done by oven-drying methods, namely: (1) the A.O.A.C. method which calls for drying at 100°C for 10-12 hours, (2) Hawaiian method which prescribes drying on silica sand at 100-105°C for five hours, (3) "Filter Paper" method which makes use of two pieces of filter paper in drying molasses samples for two and one-half hours.

Results of comparing these methods to select one that would give fairly comparable and consistent results, showed that the "Filter Paper" method gave no definite drying period that agreed with those of the other methods. One and a half hours drying proved sufficient for determination of moisture in final molasses, sample 1, but it required two hours for A-molasses and final molasses, sample 2.

The loss in weight by the "Filter Paper" method was greater by two milligrams for every half hour compared with that of the A.O.A.C. method with equal moisture contents obtained in both. Further studies on the "Filter Paper" method will have to be made before it can be recommended to substitute for the A.O.A.C. method.

—R. PONCIANO N. OBED

THE CENTRAL EXPERIMENT STATION

LIST OF AVAILABLE PUBLICATIONS

No. 2.—Bud Rot of Coconut ..... *By G. O. Ocfemia*

No. 8.—Horse Breeding in the Philippines ..... *By V. Villegas*

No. 11.—The New College Copra Drier ..... *By Moises M. Kalaw* (Revised)

No. 17.—College Trapnest ..... *By F. M. Fronda and P. S. Paje*

No. 18.—Surveying for Area with a Surveyor's Staff ..... *By Alexander Gordon*

No. 23.—Curing Pork and Making Sausage for Home Use ..... *By Mariano Mondoñedo*

No. 24.—Construction and Operation of Silos in the College of Agriculture ..... *By J. P. Esguerra*

No. 29.—Collegiate Education in Agriculture ..... *By Leopoldo B. Uichanco*

No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? ..... *By N. B. Mendiola*

No. 33.—Kenaf Culture ..... *By P. A. David*

No. 34.—Vanilla Culture ..... *By P. A. David*

No. 35.—Black Pepper Culture ..... *By P. A. David*

The price of the circulars listed above is thirty centavos (₱0.30) each.

All orders for circulars with payment should be addressed to the Business Manager, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines.

PHILIPPINE AGRICULTURE, Volume 2 { Clothbound ..... ₱7.50 / Postage 0.40

A MANUAL OF PLANT BREEDING FOR THE TROPICS ..... ₱6.00

All orders for books with remittance should be addressed to

THE DEAN AND DIRECTOR
COLLEGE OF AGRICULTURE AND
CENTRAL EXPERIMENT STATION
COLLEGE, LAGUNA, PHILIPPINES

The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

Vol. I—2

Vol. III—9-10

Vol. V—2, 6, 7, 9, 10

Vol. VI—1, 2, 3, 4, 6, 7, 8, 9, 10

Vol. VII—complete

Vol. VIII—3, 4, 5, 6, 8-9, 10

Vol. IX—3, 4-5, 8-9

Vol. XI—3, 7, 8

Vol. XIII—1, 10

Vol. XIV—1, 2, 3, 4, 5, 6, 7, 9, 10

Vol. XV—complete

Vol. XVI—3, 8, 9, 10

Vol. XVII—6, 7, 8, 9, 10

Vol. XVIII—complete

Vol. XIX—complete

Vol. XX—complete

Vol. XXI—complete

Vol. XXII—complete

Vol. XXIII—1, 2, 3, 4, 6, 7, 8, 9, 10

Vol. XXIV—complete

Vol. XXV—complete

Vol. XXVI—complete

Vol. XXVII—complete

Vols. XXVIII, XXIX, and XXX—burned

Vols. XXXI to XXXIX—complete

Back copies of Vols. I to XXVIII sell at 50 centavos and back copies of Vols. XXXI to XXXIX sell at ₱1.50.

Send your order to the BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, COLLEGE, LAGUNA, PHILIPPINES.